

Journey of Life on Earth:

***Conversing with Dante
in Dream {2}***

Art Aeon

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with Dante in Dream {2} (2019)***

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Conversing with Dante in Dream

A Dreamer's Tale One:

Dante's Poem of Light

Tale Two:

Journey of Life on Earth

Tale Three:

Mystery of the Universe

Journey of Life on Earth: Conversing with Dante in Dream {2}

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Journey of Life on Earth: Conversing with Dante in Dream {2}

This work is the middle part (Tale Two) of a fictional narrative poem in the tercet stanza. It unfolds an imaginary conversation between two characters in a dream: A sincere heathen dreamer and the spirit of his revered poet, Dante (1265- 1321): the author of *The Divine Comedy*. The present work was inspired by Dante's *Divine Comedy* to follow its form and spirit as much as it may be feasible.

At the end of the first part, *Dante's Poem of Light*, the character-dreamer confesses to the character-Dante that he wishes to write a narrative poem about what he has experienced and learned on the nature of life. He hopes to achieve it in the mode of Dante's sublime artistry of *The Divine Comedy* rather than Lucretius's didactic style of *On the Nature of Things*. He entreats Dante to guide him to learn how to fulfil his dream. With sincere curiosity, Dante encourages him to unfold what he dreams to write on the nature of life.

The dreamer's Tale Two consists of the following sixteen episodes, each called *Song* (similar to the Dante's *Canto*).

NOTE: The technical terms used in this work are indicated by quotation marks in *italics* (e.g., “*DNA*”, “*cell*”, “*genome*”). For their scientific explanations and relevant references, please consult the website of **Wikipedia.org**.

Song 1: *The Beginning of Each Individual’s Life*

The dreamer starts to unfold how each individual begins one’s journey of life. Despite the enormous “*diversity of organisms*,” every individual comes from a single, tiny “*fertilized egg-cell*” via its orderly “*embryonic development*.” The crucial event which actuates the beginning of a new organism, called “*fertilization*,” is the biological union of an “*egg-cell*,” produced by the mother, and a “*sperm-cell*,” coming from the father. Each organism is endowed with its unique “*genome*,” inherited from its parents. It is a whole set of very long “*macromolecules*,” called “*DNA*.” It may be regarded as a “*book of genetic information*” that carries instructions and plans for the new organism how to construct the unique architecture of its body, and how to carry out proper actions for successful living amid ever-changing conditions of the “*environment*.”

Song 2: *The Early Dark Journey of Our Life*

The initial journey of our life during the nine-month “*gestation*” in our mother’s womb is hidden in the dark. But it is the most decisive episode in which very critical events occur in the “*embryo*.” The “*generation of new cells*,” the “*morphogenetic migration*” of cells, and the formation of various “*proto-organs*” construct the complex integrated structures and functions of our body. First, the number of cells increases exponentially via the “*mitotic cell generation cycles*.” Second, groups of cells migrate in orderly morphogenetic movements and redistribute themselves within the embryo such that they form three “*primary germ layers*.” Different regions of the *primary germ layers* develop into rudiments of various future organs. From the outer layer, called “*ectoderm*,” develop the “*nervous systems*,” the “*epidermis*,” and others. From the middle “*mesoderm*” come muscles, the “*urogenital system*” and other connective tissues. From the inner “*endoderm*” develop the “*respiratory system*,” the “*reproductive system*” and others. Each cell acquires its specific structure and function according to its provenance in the embryo: the “*fate map*.”

Song 3: *Functional Structure of the Genome*

The genetic information inheres in the particular molecular structure of DNA, which is composed of two complementary long strands; they intertwine each other to form a “*double-helix*.” Each strand, called “*poly-nucleotide*,” is composed of a very long linear sequence of simpler units, called “*nucleotides*.” Each nucleotide is made of one of four types of “*nucleobases*,” which protrudes from the stable “*sugar-phosphate backbone*” of the strand. The four types of nucleobases are “*cytosine*” [C], “*guanine*” [G], “*adenine*” [A], and “*thymine*” [T]. Due to their particular chemical structures, [C] can pair only with [G] via three “*hydrogen bonds*” (weak attractive electric force), whereas [A] can pair only with [T] via two *hydrogen bonds*, in accord with the universal principles of physics. The two complementary strands of the helical DNA are bound via *hydrogen bonds* along the entire stacks of “*pairing nucleobases*” between the two helical strands. The specific linear sequence in the distribution of the four types of nucleobases, [A], [C], [G], and [T], along each strand constitutes its specific “*genetic information*.” Hence, the wisdom of life may be regarded to have been written in linear sequences of four alphabets on the molecular book, made of very long strands of DNA.

At this point, Dante summarizes what he gathered from the dreamer’s tale so far: DNA is an inheritable but

inert depository, just a book. Others have written the crucial biological information and instructions for someone else to read it and use it properly in the journey of life. If so, Dante asks who the wise author of the book of genetic information is. Who are the discerning readers of DNA? And who can use its vital genetic information timely to solve complex problems in the real journey of life?

Song 4: *Enzymes Read and Use Genetic Information*

The dreamer appreciates Dante's insightful questions: As for the discerning readers of DNA and the executive users of its genetic information, he says that there are various kinds of active molecular agents, called "*enzymes*," and "*gene regulatory factors*." But they are not the original author of the genetic information. They have been produced as proscribed by the genetic information. The linear sequence of nucleotides along DNA is "*translated*" into its corresponding "*co-linear sequence of amino acids in proteins*." Specific regions of DNA, called "*coding regions*" or "*genes*," are first "*transcribed*" into a single-stranded polynucleotide, called "*ribonucleic acid*" (RNA). The synthesis of the RNA strand, known as "*DNA-transcription*," proceeds as follows: one of the two strands of DNA is exposed as a "*template*" for the synthesis of its "*complementary base-*

pairing single-strand RNA” by an enzyme, called “*DNA-directed RNA polymerase*.” When the “*transcription of the coding segment of DNA*” into its corresponding complementary RNA strand is completed, the DNA restores its double-helical structure, and the newly synthesized RNA strand, called “*pre-messenger RNA*,” is released in the nucleus of the cell. At this point, Dante asks how the enzyme can choose which relevant part of the enormous book of DNA to transcribe.

Song 5: *Molecular Drama of Gene Expression*

DNA has many specific regions, called “*enhancers* or *promoters*,” where the initiation of a “*gene transcription*” may occur. A *promoter* region contains specific DNA sequences, called “*response elements*,” to which various DNA-binding proteins, called “*transcription factors*,” bind to regulate transcription. The *factors* which activate an initial binding site for the RNA-polymerase to begin the transcription of that particular DNA segment are called “*activators*.” “*Repressors*” are transcription factors that inhibit transcription of one or more *genes* by blocking the attachment of *RNA-polymerase* to the promoter sites of DNA. The various *transcription factors* are orderly regulated by diverse vital signals of the on-going situations of each cell.

Song 6: *Editing and Using Genetic Information*

When the living conditions send signals that enhance *activators* to bind to the *response elements* of the *promoter* sites of DNA or inhibit *repressors*, then *DNA-directed RNA-polymerase* binds to the promoter region of DNA and begins to transcribe its genetic information. The bound *RNA-polymerase* unwinds the local double-helical strands of DNA such that only one strand of the exposed sequence of the nucleotide can be used as a template for synthesis of its corresponding complementary single-strand RNA, called "*primary transcript*." Several types of *RNA-polymerases* produce different kinds of *primary transcripts*: The "*RNA-polymerase II*" synthesizes the "*pre-messenger RNA*," which are variously modified to become the "*messenger RNA*" [m-RNA]. Then they are exported from the nucleus to the cytoplasm so that the [m-RNA] can be used as templates for the production of their corresponding proteins at a complex structure called "*ribosomes*."

Dante asks: If the *primary transcripts* are modified, the content of the edited text must be quite different from the original version, inscribed on the DNA. Why do such severe alterations occur? The dreamer replies: A "*protein-coding segment*" of DNA has many distinct nucleotide-sequences, called "*DNA-introns*." The corresponding sequences in the *primary RNA transcript*, called "*RNA-introns*," are removed via

complex “*catabolic processes*,” called “*RNA-splicing*,” which convert a *precursor messenger RNA* into the final product of [mRNA]. When all non-coding parts (RNA-introns) are removed from a *primary RNA transcript*, the remaining coding regions, called “*exons*,” are joined together to produce a “*protein-encoding messenger RNA*.” The juxtapositions of coding *exons* and non-coding *introns* make it possible to splice them differentially such that a *single gene* may code for many *different proteins*.

Song 7: Spontaneous Changes of the Genome

The genome is not a fixed static entity like a finished old book. But it is a dynamic process of living, which undergoes constant changes according to the ever-changing conditions of various levels of its environments. “*Radiations*” and “*mutagenic chemicals*” randomly change its nucleotide-components, which result in its “*mutations*.” “*Insertion*” or “*deletion*” of various mobile segments of DNA, called “*mobile genetic elements*,” can cause significant changes in the genome. “*Retrotransposons*” are mobile elements that can be multiplied and inserted into the same genome at various locations. An RNA transcript of *the mobile DNA segment* is used as a template by “*reverse transcriptase*” to produce many extra copies of the DNA segment and insert them back to random locations of the same genome. Various “*deletion mutations*” occur due to loss of DNA segments by errors during “*DNA replication*” or “*chromosomal cross-over*.” It results in the “*recombination*” of genetic

information via the exchange of DNA segments by *cutting* and *pasting* between different organisms to procreate their offspring so that they inherit the newly recombined novel genome. Some DNA segments such as “*plasmids*” and “*viral mobile elements*” can be transferred from one species to foreign species horizontally via “*transfection*.” New genes can be formed via duplications of an *ancestral gene* and subsequent variant mutations of its multiple copies in the genome. Hence, by its nature, the genome evolves gradually from its simple and primitive to more complex and elaborate forms via the long *trial-and-error* processes, called “*natural selections*” over billions of years on Earth, without any intentional and omniscient author.

Song 8: *Evolution of Diverse Organisms on Earth*

All known organisms on Earth are classified into three major *domains*: “*Bacteria*,” “*Archaea*,” and “*Eukarya*.” *Bacteria* are unicellular micro-organisms which are enclosed by cell-walls but lack a nucleus and other “*organelles*.” They are the most ubiquitously distributed organisms that thrive in soil, water, and air, as well as in animals and plants. *Archaea* are micro-organisms which are similar to *Bacteria* in structure but radically different in biochemical metabolisms. Many kinds of *Archaea* can thrive in harsh environments such

as vents of volcanoes at deep dark ocean floors, hot springs, salt lakes, and marshlands, where *Bacteria* or *Eukarya* cannot survive. *Eukarya* have more elaborate structures such as “*nucleus*” and other “*organelles*.” About one and a half billion years ago, more complex *multicellular organisms* which were composed of many cells that were integrated into a whole evolved in *Eukarya*. They are the advanced forms of life familiar to us: both the “*Animal kingdom*” and the “*Plant kingdom*” belong to *Eukarya*.

Recent molecular comparisons of many diverse genomes revealed that they shared a set of *common genes*, regardless of whether they were sampled from *Bacteria*, *Archaea*, or *Eukarya*. Hence, the *set of common genes* is inferred to have been passed down from an ancient population of primitive unicellular, prokaryotic micro-organisms, called “*last universal common ancestor*,” from which all known organisms have evolved.

The oldest fossils of primordial animals are about seven hundred million years old. Since this momentous event, the evolution progressed rapidly. Between six and five hundred million years ago, diverse kinds of “*algae*” and “*invertebrates*” prospered. Then “*primitive vertebrate*” fishes emerged about four hundred fifty million years ago. Between four and three hundred fifty million years ago, “*amphibians*” and “*insects*” began to live on lands. Fossil records also reveal extreme events

of massive “*extinctions of organisms*” due to catastrophic changes in their environments. Many kinds of marine invertebrates perished three hundred million years ago. Following the major extinction, “*reptiles*” and insects prospered on lands. Giant reptiles, called “*dinosaurs*,” dominated the lands for one hundred-thirty million years long. Suddenly they suffered *abrupt extinction* due to the drastic impact of a vast “*asteroid*,” sixty-six million years ago. Then various kinds of mammals and birds prospered on the lands. About forty million years ago, “*anthropoid primates*” such as “*monkeys*” and “*apes*” emerged in lush forests. “*Gibbons*,” “*orangutans*,” “*gorillas*,” and “*chimpanzees*” are the surviving kinds of apes whose features and behaviours resemble closely to those of the humans.

Song 9: *Emergence of Humankind*

Fossils of bone fragments of various kinds of extinct great apes found in Africa suggest that they underwent gradual yet radical changes from the “*quadrupedal*” to “*bipedal*” mode of locomotion between five and two million years ago. The extinct great apes, called “*Australopithecus*” could walk, but they did not leave any evidence of making tools.

About two million years ago, “*Homo habilis*” which had a larger cranium size and anatomical features more similar to ours, emerged; they were not only bipedal but also avid makers of “*stone tools*.” Then a new species, called “*Homo erectus*,” emerged about one and a half million years ago and lasted as recently as to about three hundred thousand years ago. They were taller and more robust than us with large brains. *Homo erectus* lived in caves or built their shelters. They used animal hides as clothes and improvised many new useful stone tools. They were the first humans who learned how to *handle fires*. They undertook bold, adventurous migrations from their small tropic habitat in Africa to new vast territories of strange challenging environments; their fossils were found in diverse regions of Asia and Europe.

About five hundred thousand years ago, new species, called “*Homo sapience*,” emerged. The fossils of these archaic humans, found in Africa, Europe, and Asia, show various mosaic intermingled traits of both the *Homo erectus* and the anatomically modern humans (*Homo sapience*). The most available fossils of the archaic humans, called the “*Neanderthals*,” reveal that they lived from two hundred thousand to as recently as forty thousand years ago across wide ranges from western and central Europe to

central Asia. The most remarkable feature of the *Neanderthals* was their great cranial capacity, which was as large as, or even exceeded that of the modern human. They produced a great variety of tools made of animal bones as well as stones. They created stone pendants for artistic use as personal ornaments rather than for practical applications such as blades, hand axes, spears for hunting and cutting. Red ochre and other natural pigments were found in their caves, but their presumed work of art did not survive the ravage of time. The earliest fossils of the anatomically modern humans, *Homo sapiens sapiens*, are two hundred thousand years old. A small population of these modern humans moved out of Africa seventy thousand years ago. They dispersed widely and inhabited the whole globe successfully. By thirty thousand years ago, they eventually replaced then co-existing archaic humans, such as the *Neanderthals* and others; they became extinct in the stark severe struggles for existence.

About ten thousand years ago, our ancestors began to cultivate crops and domesticate animals for foods and other essential uses. Hence, their nomadic tribe became the new, larger, settled agricultural societies that eventually developed to the cradles of the ancient civilizations in Mesopotamia, Egypt, India, and China, between six and five thousand years ago. They invented their writing systems, which enabled them to preserve what they thought, felt, believed, and imagined as well as what happened as historical facts in their written records.

Song 10: *Artistic Creativity of Early Humans*

During the long prehistoric era, the early humans left faint but concrete traces of their mystic spiritual feelings, which we can recognize almost forty thousand years later. There are over three hundred caves that preserve ancient prehistoric works of art. The most important and astounding recent discovery is the paintings on the walls deep in the “*Chauvet Cave*” in France. In essence, this extensive darkly labyrinth has very intricate and impressive configurations that inspire breathtaking awe and wonder to any sentient beings. A few humans used the cave as a sacred sanctum for their artistic expressions rather than as a commonplace of their habitation. The oldest depictions of animal figures preserved on the cave walls were drawn or painted in black; they are estimated to be about thirty-five thousand years old.

The later paintings in the “*Lascaux Cave*” in France are dated to be seventeen thousand years old. It shows an impressive painting of a “*man with bird’s head*” mortally wounded by an enraged bison. It looks to tell a symbolic story. The heathen dreamer confesses his naïve belief that the ancient prehistoric artists might be inspired by their *inner spirituality* to express what they thought, how they felt, and what they imagined.

Song 11: *Organization of the Human Brain*

The nervous system develops from the “*neural plate*” of the embryonic ectoderm. As it folds, its two lateral edges fuse to form the “*neural tube*,” which develops three primary “*brain vesicles*”: “*forebrain*” at the front, “*midbrain*” in the middle, and “*hindbrain*” behind. The long narrow caudal part of the same *neural tube* becomes the “*spinal cord*.” The *forebrain* develops into two *secondary brain vesicles*: “*telencephalon*” and “*diencephalon*.” The *midbrain* remains as “*mesencephalon*.” The *hindbrain* develops into two secondary brain vesicles: “*metencephalon*” and “*myelencephalon*.” The *telencephalon* enlarges enormously to become the “*cerebrum*.” The *diencephalon* develops into “*thalamus*,” “*hypothalamus*,” and “*epithalamus*.” The *mesencephalon* develops into various midbrain structures. The *metencephalon* forms “*pons*” and “*cerebellum*.” The *myelencephalon* becomes “*medulla oblongata*.”

The cerebrum is the most prominent structure which consists of the “*cerebral cortex*” and other “*subcortical neural structures*.” The *cerebral cortex* is the center which integrates various neural information. It carries out complex neural processing, which are involved in “*perception*” of different “*stimuli*,” “*attention*,” “*execution of willful movements*” of various parts of the body, “*thinking*,” “*planning*,” and “*communicating*” with other human brains.

Each “*hemisphere of the cerebral cortex*” is demarcated into four main “*lobes*”: “*frontal lobe*,” “*parietal lobe*,” “*occipital lobe*,” and “*temporal lobe*.” These different *lobes* are involved in performing their specific neural functions. The *occipital lobe* processes “*vision*.” The *parietal lobe* is involved in “*somatosensory perception*.” The “*posterior half of the frontal lobe*” controls the voluntary movements of the body. And the “*anterior part of the frontal lobe*” is involved in carrying out “*abstract mental functions*” such as “*thinking*” and “*planning*.”

Song 12: *Neurons and their Synaptic Networks*

The nervous system in all organisms is composed of the structural and functional units, called “*neurons*,” and of “*glial cells*” which support the *neurons* in various ways. Various “*sensory neurons*” operate on the information received from the external or internal environments. Specific “*receptor cells*” such as visual, auditory or tactile modes convert the various information, encoded in the particular stimuli such as light, sound, or touch into the “*electrical potential differences*” across the “*electrically excitable plasma membrane of neurons*.” Such conversion is called “*neural transduction*.” The transduced sensory information is processed via many stages of complex “*synaptic integrations*” along the sensory pathways which project into the specific regions of the *cerebral cortex*. The

“visual pathways” project into the *“primary visual cortex”* in the *occipital lobe*, whereas the *“auditory pathways”* to the *“primary auditory cortex”* in the *temporal lobe*. The *“tactile information”* from the whole body is conveyed to the *“somatosensory cortex”* in the *parietal lobe*. These sensory projections are organized in *“topographic orders,”* maintaining *“contiguity”* between the *location of stimuli* and that of their corresponding neurons in the *cerebral cortex*. Each neuron has its unique *“receptive field,”* which processes specific features of the stimuli that can excite the neuron selectively.

The performance of proper action requires *“planning of appropriate programs”* and *“execution of coordinated sequential movements”* of various parts of the body. The *“primary motor cortex”* in the *frontal lobe* is responsible for the performance of the intended actions. It is composed of many millions of *“upper motor neurons,”* which innervate distant *“lower motor neurons”* in the *“ventral horn of the spinal cord.”* The adjacent broader region, called the *“premotor cortex,”* is involved in the preparation of *“movement programs”* and appropriate sensory guidance of movements. The dorsal edge of the motor cortex, called *“supplementary motor area,”* has versatile motor functions. Its neurons are active during learning tasks of a specific sequence of movements.

The versatile and subtle functions of the nervous systems come from the vast number of possible “*spatial and temporal patterns of neural activities*” via intricate and complicated “*synaptic interconnections*” among extensive networks of many billions of neurons.

Song 13: *Cognitive Functions of the Human Brain*

Examples of the implicit subjective experiences of one’s cognitive functions are “*attending to, perceiving, memorizing, recalling, thinking, planning, imagining, deciding, and being aware of one’s on-going mental functions.*” The anterior part of the frontal lobe called the “*prefrontal cortex*” is one of the structures which control various “*cognitive functions.*” “*Memories*” are the brain’s mental functions that “*encode,*” “*store,*” and “*retrieve*” different vital information. “*Sensory memory*” keeps only briefly the information sent by various sensory organs. It rapidly decays unless it is selected for conversion into “*working memory*” by cognitive “*attention.*” *Working memory* can retain only limited items of information during a short period. Selected information held tentatively in *working memory* can be consolidated into “*long-term memory,*” which has an enormous capacity and duration for storage. *Long-term memories* are classified into “*explicit memory*” and “*implicit memory*”. The explicit memories are either “*semantic*” or “*episodic.*” Our knowledge of objective information, which can be explicitly represented by

“words” is a good example of the “*semantic memory*.” The “*episodic memory*” refers to private experiences of events and their contexts. In contrast, the “*implicit memory*” refers to “*procedural knowledge*”: how to do something properly. “*Motor skills*” learned by practising are its examples.

Our “*cognitive states*” change between the “*awaken state*” and the “*sleeping state*” in a daily “*circadian rhythm*.” The “*sleeping state*” changes between the “*proper sleep stage*” and the “*paradoxical sleep stage*.” “*Dreaming*” usually occurs during the “*paradoxical sleep*.”

Song 14: On Human Communications

The “*comprehension*” and “*expression*” of abstract “*mental representations*” of ideas, emotions, and intentions by explicit use of “*language*” or other “*signs*” are the most mysterious cognitive abilities unique to the human brains. *Speech comprehension* involves the transduction of the auditory signals into neural activities in the ears. They are processed by the auditory pathways converging to the primary auditory cortex in the temporal lobe. The heard word is *decoded*, presumably by the *explicit memory systems*, into its “*referent*,” “*concept*,” and “*meaning*.” When we hear a particular “*syntactic sequence*” of words, our brains somehow figure out the “*propositional content*” or the *literal meaning* of the

heard *sentence*. They follow the “*rules of the grammars*,” proscribed by their particular sociocultural system or “*convention of their language*,” which they happened to learn and use.

Proper interpretations of actual utterances require subtle and intricate considerations of the “*pragmatic social context*” of the conversation. The comprehension of utterances requires the hearer to imagine the “*mental state*” of the speaker and the context, in addition to processing the literal meaning of the heard phonological signals.

Speaking requires much more complex mental operations. A speaker must generate the message of utterance, which involves complex neural networks. The speaker should decide on his “*intended addressees*,” such that how his speaking will affect them in the pragmatic context. It requires “*social mental representations*” of the intended addressees’ “*minds*” by the speaker.

Song 15: *Emergence of Civilizations*

About ten thousand years ago, our ancestors began to undergo massive revolutionary changes in their lifestyles, from “*hunting and gathering*” to “*farming and dwelling together*” with many new strangers in their settled communities. The human societies evolved from the small familiar bands of hunter-gatherers to the large tribes, then to states. The organizations of the human

societies underwent dramatic changes from the “*egalitarian hunter-gatherer bands*” to the “*stratified social hierarchies*”: Powerful ruling classes such as king, priest, noble, and subordinate classes: citizen, serf, and slave. The “*private protolanguage*” spoken within a *band of hunter-gatherer* must have been assimilated with those of other bands like a “*pidgin language*” in a new larger society of many strangers. Then local *pidgins* might have evolved to a common “*creole language*.” The surpluses of agricultural products increased the wealth and power of the ruling classes. Priests and poets invented countless *imaginary stories about deities, demigods, and superhuman heroes*. The oral recital of myths and public performance of rituals by the priests induced the whole population to accept the “*religion of the elite ruling classes*.” The imaginative use of the common language in making up their mythology was necessary to establish the “*public religion of the nation*,” which sanctified the political power of the ruler, deemed as bestowed by the common Deity in the newly emerged “*theocracy*,” in contrast to the old private worship of their “*personal household gods*” by the *egalitarian hunter-gatherers*. The “*invention of writing*” about five thousand years ago was a momentous event, as the human history was preserved in written texts. The invention of writing made it possible to publish the “*codes of judicial laws*” for peoples to abide by.

Song 16: *The Epic of Gilgamesh*

The oldest narrative poem thus far known is "*The Epic of Gilgamesh*," excavated recently from many archaeological sites in Mesopotamia. It was compiled and edited by a Babylonian master scribe-poet, named "*Sin-legi-unninni*" about thirty-two centuries ago. The poem had been evolved from much older, simpler versions for the preceding two thousand years. Its eloquent "*Prologue and Paeon*" reads: "*He who saw the Deep, the country's foundation, was wise in all matters! He saw what was secret; He discovered what was hidden; he brought back the eras unknown before the Deluge. He adventured far away, was weary, found peace, and set all his labours on a tablet of stone. He built the rampart of Uruk, the holy temple, Eanna, for Anu, Aruru, and Ishtar... See the tablet box of cedar; release its firm claps of bronze! Lift the lid of its secret, pick up the tablet of lapis lazuli, and read out the travails of Gilgamesh, all that the hero went through!*"

Song 17: *In Search for Objective and Universal Laws of Nature*

Following their sincere discussions on the *Epic of Gilgamesh*, Dante asks the dreamer: If the *omniscient and omnipotent deities* had never existed in reality, but they were merely fanciful fabrications of the imaginative human brains, then how the universe and all things in it have been working in such perfect harmonies.

The dreamer replies that all things and events in the universe occur naturally in accord with the objective and universal principles or laws of nature. It is impossible for humans to know perfectly the ultimate principles or laws of nature. But humans can search for them by approximate empirical methods of science. The objective scientific searches by human brains for the universal laws of nature have brought forth enlightening discoveries on which the dreamer wishes to converse with Dante, next: It is a provisional tale that will evolve as our sciences progress with time. Yet, he hopes that it is a meaningful and soul-searching story for them to converse on:

Mystery of the Universe:

Conversing with Dante in Dream {3}

Song 1

*The Beginning of
Each Individual's Life*

Song 1: *The Beginning of Each Individual's Life*

‘You dream to write a poem
on the nature of life. Although
I know little about such scientific matters, 3
I’m very interested in hearing
how you manage to unfold what
you have mused on the profound mystery of life. 6
From what point would you begin
your story on the nature of life?’
says Dante with earnest curiosity 9
and encouragement. ‘I will
start to unfold how each individual
begins one’s journey of life,’ *says the dreamer. 12*
‘Go ahead: From what and how
it happens that we have come to be
in this world, and take on the journey of 15

Song 1: *The Beginning of Each Individual's Life*

of our life?' asks Dante.

'Despite the enormous diversities
of "*organisms*," each individual comes from 18
a single tiny "*fertilized*
egg-cell" via its orderly "*embryonic*
development." This vital fact was discovered by 21
"*Theodor Schwann*" in 1839.

A human being may be regarded
as a *living cosmos* which has developed from 24
a tiny single "*cell*" to become
a complex, integrated, and thinking
organism, composed of about ten trillions of 27
interconnected living *cells*,
says the dreamer. 'How such a miracle
happens as common events in reality?' 30

Song 1: *The Beginning of Each Individual's Life*

asks Dante in surprise.

‘The crucial event which actuates
the beginning of a new *organism*, 33
called “*fertilization*”,
is the biological union of
an “*egg-cell*, ” produced by the mother, 36
with a “*sperm-cell*, ” coming
from the father. How such events
occur among the humans are the themes for 39
poets to sing as stories
of love affairs. But I can surmise
an important actual event which resulted 42
in the conception of
a human being who became
a great poet: Dante in your very person. 45

Song 1: *The Beginning of Each Individual's Life*

One day, a mature *egg-cell*
was released from the “*ovary*” of
your mother, and began its journey via 48
a narrow channel towards
her “*uterus*.” Unless the *egg-cell*
came upon a *sperm cell* and became 51
“*inseminated*,” it would have
perished and be thrown out in her
“*menstrual discharge*.” As it happened by luck, 54
the *egg-cell* was rescued,
by one *sperm-cell* out of many millions
other sperms coming from your father at that 57
critical time and place.
As soon as the one lucky *sperm-cell*
fused successfully with the *egg-cell*, sudden 60

Song 1: *The Beginning of Each Individual's Life*

chemical changes in the *egg*
prevented other *sperms* from attaining
their goals. The competition for procreation is 63
extremely severe: only
one fortunate victor by chance
out of several million other contenders. 66
Suppose that the lucky sperm
were a different one at the given
situation; there would be a daughter or 69
another son of your parents,
but the particular human being,
named Dante, could never be born, nor your 72
great immortal brainchild:
La Commedia! 'It makes me tremble
in deep humility,' says *Dante honestly*, 75

Song 1: *The Beginning of Each Individual's Life*

‘to realize that we happened
to exist by darkly chances and pure
lucks through the mysterious biological 78
event of *fertilization*.
I wish to know what makes every
individual organism unique, differing 81
from others.’ ‘“*Gregor Mendel*”
propounded in 1866 that each organism
inherits from the parents its “*genes*” that determine 84
its characteristic features,’
says the dreamer. ‘What are *genes*?’
‘They carry inherited “*genetic information*,” 87
encoded along very long
“*macromolecules*,” called “*DNA*.”
‘What you mean by *genetic information*?’ 90

Song 1: *The Beginning of Each Individual's Life*

‘It may be regarded as the texts
of instructions and plans for the new
organism how to construct the unique 93
architecture of its body,
and how to carry out proper
actions for successful survival amid 96
ever-changing conditions
of the environment. Such vital texts
are inscribed along the “*DNA molecules.*” 99
The *genetic information*
is passed down from the parents
to their offspring during its “*conception*” 102
via their egg and sperm cells
in the process of *fertilization.*’
‘You must have an exciting tale, far more 105

Song 1: *The Beginning of Each Individual's Life*

intricate and intriguing
than the Plato's abstruse *Myth of Er*,'
says Dante, beaming subtle smiles. 'Thank you, 108
Dante. It is you who
move me unfold what I dreamed of
sharing with you, even in this fleeting dream! 111
As for how the very long
molecule, called "*Deoxyribo-*
Nucleic Acid" (DNA) encodes the *genetic* 114
information, I will try
to explain it later in due course
of this challenging, in-depth discourse,' *says* 117
the dreamer. 'Move ahead as
you wish; I will follow with genuine
curiosity.' 'The *genetic information* 120

Song 1: *The Beginning of Each Individual's Life*

is orderly distributed
into a "*haploid set*" of twenty-three
types of assemblages, called "*chromosomes*" 123
in the "*nucleus*" of an *egg-cell*
or in that of a *sperm-cell*. One can
see the *chromosomes* under a *microscope*.' 126
'What is a microscope?'
asks Dante. 'It is an optical
instrument which magnifies the image 129
of a tiny object so that
we can observe it.' 'I see. What
is a *cell*?' 'It is the structural and functional 132
unit of all *organisms*, propound by
"*Matthias Schleiden*" and "*T. Schwann*,"
known as "*The Cell Theory*" since 1838,' 135

Song 1: *The Beginning of Each Individual's Life*

says the dreamer. 'Depict cell,'
says Dante. 'A cell consists of
a "semi-permeable membrane" which encloses 138
its "organic substances," called
"cytoplasm." The membrane separates
its interior from the environment and controls 141
"exchanges of materials"
between them. Such exchanges are
required for the cell to keep on living. 144
The cell carries out various
essential biochemical reactions,
called "metabolisms" inside its membrane. 147
The "nucleus" encloses
the genetic materials chromosomes
inside the "nuclear membrane" that controls 150

Song 1: *The Beginning of Each Individual's Life*

the exchange of substances
between the complex genetic
machinery and the outer *cytoplasm*.' 153

'I see. How does the crucial
event of a union between
the egg-cell and a sperm-cell occur?' *asks* 156

Dante. 'A human sperm-cell
consists of four parts: An "*ovoid head*"
contains the *nucleus* which encloses 159

the *paternal set* of
twenty-three chromosomes. The *head*
is covered by a cap-like structure, called 162

"*acrosome*" which secretes
special substances that enhance
fusion with the egg-cell; A narrow neck 165

Song 1: *The Beginning of Each Individual's Life*

contains organelles, called
“centrioles”; the “proximal
centriole” enters with the *nucleus* into 168
the *egg-cell* during
fertilization, and activates
the “*first cell-division*” of the embryo. 171
A columnar middle piece
is made of “*axial filaments*”
which are surrounded by power-generating 174
organelles, called
“*mitochondria*.” It provides
motility to the sperm-cell; a long strong tail 177
which propels the sperm-cell
to meet and fuse with the egg-cell.
In contrast, a human egg-cell has a very large 180

Song 1: *The Beginning of Each Individual's Life*

volume and many elaborated
“*protective laminar*” architecture.
Its volume is many thousand times bigger 183
than that of the motile sperm-cell.
It is protected by many smaller
“*follicular cells*”, called “*corona radiata*,” 186
which surround a thick jelly
coat, called “*zona pellucida*.”
Beneath it is a critically discerning barrier, 189
called “*vitelline layer*,”
on which rows of specific
“*receptor molecules*” are embedded. 192
These receptors determine
whether an incoming sperm-cell is
of the same species (*Homo sapience* 195

Song 1: *The Beginning of Each Individual's Life*

in the case of human)
or not. They allow only a sperm
of the *same species to fuse* with the plasma 198
membrane of the egg-cell,
known as “*acrosome reaction.*”
When a lucky sperm-cell out of many million 201
other fellow contenders
happens to fuse its head with
the egg-cell, then the sperm donates the set 204
of “*paternal chromosomes*”
in its nucleus and its proximal
centriole into the egg-cell, and then dies.’ 207
‘I see. It seems to be
a heroic drama. Who did plot it
in such an exquisite mode?’ *asks Dante.* 210

Song 1: *The Beginning of Each Individual's Life*

‘All these living cells may
be regarded as the actors who play
faithfully the plot, prescribed by the *genetic* 213
information of their own
species, passed down via their *chromosomes*
through countless generations,’ *says the dreamer.* 216

‘According to your story
of science, the Olympian gods
must be regarded as humans—*Homo sapience,* 219
because they fell in love,
and made love with human females,
and begot their children so successfully,’ 222
say Dante beaming smiles.

‘I would agree with you, Dante,
if such humanlike gods had ever existed 225

Song 1: *The Beginning of Each Individual's Life*

as the ancient Greek poets
have sung in their artistic inventions.
At any rate, let me finish my mundane tale 228
on the beginning of
each individual's life. The union
of the egg-cell with a sperm-cell makes it 231
possible to combine
the maternal "*haploid*" of twenty-
three chromosomes in the egg cell with 234
the paternal haploid
genome donated by the sperm-cell.
Hence, the fertilized egg-cell is transformed 237
into a "*diploid*" cell,
called "*zygote*," with newly combined
complete genome of forty-six chromosomes. 240

Song 1: *The Beginning of Each Individual's Life*

The “sex” of a human
is determined by the 23rd “sex-chromosome.”
An egg-cell carries only one type, called X-type. 243
But a sperm-cell carries
either an X-type, or a much
smaller Y-type sex-chromosome. If an egg- 246
cell is fertilized by
a sperm with X-type, the *zygote*
develops to be a female. Hence, it must 249
be a sperm with Y-type
sex-chromosome from your father
which happened to fertilize your mother’s 252
egg-cell at her conception
of you, Dante, I firmly aver,’
says the dreamer. ‘I see. The mystic journey 255

Song 1: *The Beginning of Each Individual's Life*

of our life begins, not
at our birth, breathing in the air,
but at the earlier, unseen, enigmatic, 258
yet very crucial events
of *fertilization* via darkly chances,
I realize,' *says Dante in deep thoughts.* 261
Suddenly Dante raises
serious questions about the Christian myths.
'The Gospel of Mathew and that of Luke claim 264
that Jesus Christ was conceived
and born by a virgin, named Mary,
through the divine power of the Holy Spirit. 267
I wonder how your story
would account for the virgin birth
of Jesus.' 'My story has nothing to do 270

Song 1: *The Beginning of Each Individual's Life*

with such fanciful fables.
If there were any concrete remains
of Jesus's body—bones, skins, or hairs, one could 273
extract his *genome*, and
compare them with those of other
humans. If the presumed Holy Spirit did not 276
contribute its *genomes*
to the virgin Mary's *egg-cell*, as
claimed by the authors of those Gospels, 279
then the Jesus's *genome*
must be only a *haploid*, contributed
by his virgin mother who had only *X-type* 282
sex-chromosome. If so,
the virgin-conceived Jesus could not be
a male but a female with only a half amount of 285

Song 1: *The Beginning of Each Individual's Life*

her mother's genome.
If Jesus was, indeed, a man,
then he should have possessed a *Y-chromosome* 288
which must be contributed
to Jesus by the Holy Spirit.
That is what one can comment on the fables,' 291
says the dreamer with
resolute conviction. 'I see.
According to the laws of nature, 294
the Holy Spirit must have
contributed the human male's Y-type
sex-chromosome to the virgin Mary's egg-cell 297
at her conception of
Jesus Christ,' *murmurs Dante.*
'Only if one trusts in the fanciful fables.' 300

Song 1: *The Beginning of Each Individual's Life*

‘I have been used to take it
for granted that our babies are born
naturally, without knowing how the birth 303
really happens. It was
a miraculous, lucky, pure chance which
allowed me to live, and to grow up to become 306
a conscious human being
who is aware of his existence
in this world, and looks into the very mystery 309
of one’s journey of life.
Please unfold your mystic epic how
the fertilized egg-cell in my mother’s womb 312
had transmuted itself to
become this conscious human being,’
says Dante in awe with sincere curiosity. 315

Song 2

The Early Dark Journey of Our Life

Song 2: *The Early Dark Journey of Our Life*

‘The *initial journey*
of our life during the nine-month
gestation in our mother’s womb is hidden 3
in the dark. But it is
the most decisive episode in which
very critical events occur in the *embryo*. 6
Its primary features are:
Generation of new cells, “*morpho-*
genetic migration” of cells within the embryo, 9
and formation of various
“*proto-organs*” to build up the complex
integrated structures and functions of our body. 12
First, the “*zygote*” generates
new cells through the “*mitotic cell*
division cycles”. The single-cell *zygote* 15

Song 2: *The Early Dark Journey of Our Life*

divides into two cells.
Then each new daughter cell produces
two new cells of the next generation, and so on. 18
The number of cells increases
rapidly from one, two, four, eight,
sixteen, and so on, but their size gets smaller 21
in the exponential pattern
as the *mitotic cycles* progress.
Each new cell carries the whole set of *genome*, 24
duplicated before each
mitotic cell generation cycle
completes. At this early stage of the embryo, 27
called “*blastocyst*,” each cell
has the potential to develop into
any type of cells later. At the next step, 30

Song 2: *The Early Dark Journey of Our Life*

called “*gastrulation*,”
groups of cells migrate in orderly
morphogenetic movements and redistribute 33
themselves within the embryo
such that they form the three “*primary*
germ layers:” the outer layer, “*ectoderm*,” 36
the middle “*mesoderm*,”
and the inner “*endoderm*” of
the embryo. Different regions of the *primary* 39
germ layers develop
into the rudiments of various
future organs: from the *ectoderm* come 42
the “*nervous system*,”
the epidermis, the cornea and lens
of the eye, the epithelium of oral and 45

Song 2: *The Early Dark Journey of Our Life*

nasal cavities, and others.
From the *mesoderm* develop
muscles, bones, blood, endothelium of blood 48
vessels, lining of body
cavities, the urogenital system,
and other connective tissues. From the *endoderm* 51
develop the digestive
tracts, the epithelia of respiratory
tract, the reproductive ducts and glands, 54
the urethra, and bladder,
and so on,' says *the dreamer*. 'If so,
the fates of these cells are determined by 57
their locations, I surmise,'
says *Dante*. 'Yes. Each cell acquires
its specific structure and function in accord 60

Song 2: *The Early Dark Journey of Our Life*

with its provenance in
the embryo; the “*fate map*” becomes
firmly fixed at this stage, about twelve weeks 63
after the fertilization.
The emergence of the *nervous system*
is very prominent as well as crucial events: 66
A portion of the *dorsal*
region of the ectoderm must be
induced by *intercellular interactions* 69
with the underlying
mesoderm to be the progenitor
of neural tissues, called “*neural plate.*” 72
If the interactions are
prevented in experiments on animals,
the region becomes epidermis; such a gravely 75

Song 2: *The Early Dark Journey of Our Life*

defective brainless embryo
becomes aborted. In healthy development,
parallel ridges, called “*neural folds*,” at the left 78
and right margins of
the *neural plate*, protrude to
the midline and fuse to form the “*neural tube*.” 81
The rostral part of the neural
tube undergoes very complex enlargements,
called “*encephalization*,” to form the *forebrain*, 84
the *midbrain* and the *hindbrain*.
The remaining caudal part of
the neural tube becomes the long tubular 87
“*spinal cord*,” which forms
the “*central nervous system*” with the brain.
The hollow inside of the neural tube becomes 90

Song 2: The Early Dark Journey of Our Life

the “*cerebral ventricles*”
and the “*spinal canal*,” filled with
the “*cerebrospinal fluid*.” The peripheral 93
nervous system develops
from two groups of precursor cells,
called “*neural crests*.” They migrate laterally, 96
and give rise to the “*spinal*
and autonomic ganglia” through which
the entire parts of our body are interconnected 99
with the *brain* and the *spinal*
cord to make us as the *integrated*
organism. But the various versatile 102
functions of our nervous
systems keep on developing
during many years after the birth. We cannot 105

Song 2: The Early Dark Journey of Our Life

remember what happened
during our early dark journey
in the womb nor in our infancy after 108
our birth as our memory
functions had not developed at these
early periods. Despite our utter ignorance, 111
however, what happens
during the initial dark journey
is the most decisive, critical as well as 114
miraculous events
which have enabled us to exist.
If anything goes wrong in the extremely 117
complex and delicate
processes in our early dark journey,
it will affect us gravely. Toxic materials can 120

Song 2: *The Early Dark Journey of Our Life*

cause *abortion* or various
“*congenital malformations and*
diseases”. The genetic information 123
of the zygote may contain
defects which will mislead its proper
development. The embryo depends entirely 126
on its mother for appropriate
supplies of essential nutrients
and critical protection for its survival 129
and the safe delivery
at the end of its dark journey
to breathe in the air and see the light at its birth. 132
Changes in the mother’s
health can cause critical defects
in her future child. At very early stage, 135

Song 2: The Early Dark Journey of Our Life

the *embryo* has astounding
“*plasticity in its development.*”
If the *zygote* is accidentally split 138
into two separate
zygotes, each one of the halved zygote
can develop to become “*identical twins*” 141
who have precisely the *same*
genomes.’ ‘I know such twins who looked
amazingly similar to each other,’ *says Dante,* 144
‘They showed remarkably
similar behaviours and mental
attributes.’ ‘Longitudinal studies on many thousand 147
cases of the “*monozygotic*”
human twins confirm the important
fact you noticed. The individual *genome,* 150

Song 2: *The Early Dark Journey of Our Life*

one happens to take on
by chance at the fertilization,
imposes crucial instructions on how to build up 153
one's own body and attain
various versatile functions in
one's later journey through ever-changing 156
conditions of one's living
in this real world,' *says the dreamer.*
'Yes. I realize the critical importance 159
of the unseen early dark
journey of our life, which we are used
to taking for granted. Please explain what *genome* 162
really is, and how it
carries out its mysterious works
hidden deep inside our body,' *says Dante.* 165

Song 3

Functional Structure of the Genome

Song 3: *Functional Structure of the Genome*

‘You have asserted that each
organism is its own maker
who has built its body during embryonic
development, and its unique
master who controls its own mind
to sail successfully across the uncertain,
immense, deep sea of being.
How could it be possible for
an egg-cell to acquire such an amazing
practical wisdom of life,
when a sperm happened to fertilize it
by darkly chance?’ *asks Dante with genuine
curiosity.* ‘Each organism
acquires its own unique *genome*
that combines the two *haploid sets* of

Song 3: *Functional Structure of the Genome*

chromosomes inherited
from its parent via the *fertilization*.
The complete set of combined chromosomes 18
is the physical bearer
which conveys the essential and
vital “*genetic information*,” or the “*wisdom* 21
of life” as you paraphrase it
so poetically,’ *says the dreamer*.
‘Tell me how does the chromosome actually 24
convey the genetic
information,’ *says Dante*. ‘Each
chromosome is an orderly compacted 27
package of a single,
extremely long, biological
molecule, called “*deoxyribo-nucleic acid*” (DNA). 30

Song 3: Functional Structure of the Genome

Parts of the long *DNA*
molecule attach to and wrap around
“*histone octamers*” to form “*nucleosomes.*” 33
They look like beads-on-a-string,
called “*chromatin fibres.*” They are
packaged with “*proteins*” into condensed 36
structures, called “*chromatins.*”
During the “*cellular division,*”
the *chromatins* condense further to form 39
the “*chromosome,*” which is
visible under a light microscope.’
‘If *DNA* is the physical substance of 42
the mysterious “*thread*
of life”, how does it carry the vital
and practical wisdom of life?’ asks *Dante.* 45

Song 3: *Functional Structure of the Genome*

‘The *genetic information*
inheres in the particular
molecular structure of DNA. 48

DNA is composed of
two complementary long strands which
intertwine each other to form a “*double helix*.” 51

Each strand is called “*poly-nucleotide*.” It is composed of
a very long, linear sequence of simpler 54
units, called “*nucleotides*.”

Each *nucleotide* is composed of
one of four types of “*nucleobases*” which 57
protrudes from the stable

“*sugar-phosphate backbone*” of the strand.
The four types of nucleobases are “*cytosine*” [C], 60

Song 3: *Functional Structure of the Genome*

“*guanine*” [G], “*adenine*” [A],
and “*thymine*” [T]. Because of their
particular chemical structures, [C] can pair 63
only with [G] via three “*hydrogen
bonds*” (weak attractive electric force);
whereas [A] can pair only with [T] via two 66
“*hydrogen bonds*”, as propounded
by “*James Watson*” and “*Francis Crick*”
in 1953. The two complementary strands 69
of the helical DNA are
bound via *hydrogen-bonds* along
the entire stacks of “*pairing nucleobases*” 72
between the two strands.
The “*specific linear sequence*”
in the distribution of the four types 75

Song 3: *Functional Structure of the Genome*

of *nucleobases*—[A], [C], [G]
and [T]—along each strand constitutes
its “*specific genetic information.*” Hence, 78
the *wisdom of life* may be
regarded to have been written in
the *linear sequences of four alphabets* 81
on the molecular book,
made of very long strands of DNA,’
says the dreamer with fervid enthusiasm. 84
‘It sounds like the enthralling
Greek myth on the mysterious thread
of life, handled by enigmatic goddesses of fate. 87
You must have, I surmise,
very intricate stories of vital
importance to unfold how a concrete 90

Song 3: *Functional Structure of the Genome*

physical substance, called
DNA, could embody such essential
instructions for life, and mete it out properly 93
whenever it is needed
in the ever-changing journey
of life,' says *Dante with great curiosity.* 96
'Thank you, Dante, for your
encouragement with such perceptive
insights on the complex and complicated stories 99
on the mystery of life.
I confess that what I try to tell
is merely a temporary account of 102
the on-going researches
by many devoted outstanding scientists
as much as I could understand their difficult 105

Song 3: *Functional Structure of the Genome*

works. They are incomplete
and provisional stories; yet I hope
that they make a good sense to you,' *says* 108
the dreamer. 'I know
that it is challenging to tell
such a story without confusing yourself 111
let alone your audience.
Make it simple to the point. What
I gather from your complicated story is this: 114
DNA is an inert
depository, inherited from parents;
It's just a book, on which the essential 117
information and instructions
had been written by unknown authors
for other agents to read and use it timely 120

Song 3: *Functional Structure of the Genome*

in the journey of life.’
‘Yes, Dante! That is the main point
I wished to make,’ *says the dreamer in delight.* 123
‘Then, tell me who the wise
author of the book of life—DNA—is.
Who are the intelligent readers of DNA? 126
And who are the executive
agents that use DNA’s information
to solve timely intricate problems of living?’ 129
asks Dante. ‘I appreciate
your perceptive and constructive
questions. As for the unknown authorship 132
of the information,
inscribed into DNA, I will
try to discuss plausible conjectures later. 135

Song 3: *Functional Structure of the Genome*

As for the intelligent
readers and the executive users
of the genetic information, inscribed in DNA 138
there are various kinds
of active molecular agents,
called “*enzymes*” and “*gene regulatory factors*.” 141
Before we move to the next
episodes in the intricate and
complex story of life, I wish to emphasize 144
two main points in this
episode about DNA: First, it
has four types of *chemically discerning* 147
nucleobases such that
their mutually attractive pairings
occur selectively only between [A] and [T], 150

Song 3: Functional Structure of the Genome

or between [G] and [C]
via *hydrogen-bonds* between them
in accordance with the laws of physics. 153
Second, the many possible
“*permutations of the sequences*”
in the *linear distribution* of the four types 156
of nucleobases along
each one of the long complementary
strand of the double-helical structure of DNA 159
has an “*immensely large*
capability” for conveying various
information, which can be transmitted from 162
one generation to the next:
For examples, the longest human
“*Chromosome 1*” is composed of about two hundred 165

Song 3: *Functional Structure of the Genome*

forty-nine million base-pairs;
The shortest “*Chromosome 21*” has
about forty-seven million base-pairs; the human 168
“*X-Chromosome*” is composed
of about one hundred fifty-six
million base-pairs, whereas “*Y-Chromosome*” 171
is about fifty-seven million
base-pairs long. Therefore, the complete
diploid human genome is an enormous book, 174
written with a huge number
of about six and a half billion
base-pairs of [A], [C], [G], and [T],’ says 177
the dreamer. ‘I see your point.
Move on to the next episode in
your fascinating story on life,’ says *Dante*. 180

Song 4

***Enzymes Read and Use
the Genetic Information***

Song 4: *Enzymes Read and Use the Genetic Information*

‘You claim that “*enzymes*” are
the discerning readers of DNA,
and the active agents who can use properly 3
its vital information
for living. Tell me what *enzymes* are,
and how they could carry out the complicated 6
and intricate processes
of life,’ says *Dante with earnest*
curiosity. ‘*Enzymes* are “*catalytical* 9
molecules” which enhance
the biochemical reactions
necessary for “*metabolic processes*” 12
in every living cell.
Most *enzymes* are “*catalytical*
globular proteins”, but some are made of 15

Song 4: Enzymes Read and Use the Genetic Information

“*ribonucleic acids*” (RNA),
called “*ribozymes*,” which have
catalytical functions,’ *says the dreamer*. ‘What 18
is *metabolism*?’ ‘It is
all of the biochemical reactions
in any organism which are necessary 21
to sustain its living.
They convert the external
materials, taken in from the environment 24
such as foods, air, and light
into building blocks for production
of the essential macromolecules such 27
as “*proteins, nucleic acids,*
lipids, and carbohydrates.” Also,
they can generate the necessary energy 30

Song 4: Enzymes Read and Use the Genetic Information

which enables and sustains
the active processes of living.
A “*catabolic metabolism*” breaks down complex 33
compounds into simpler
units, usually releasing energy.
In contrast, an “*anabolic metabolism*” 36
carries out elaborate
syntheses of vital macromolecules
such as *proteins* from *amino acids*, and DNA’s 39
and RNA’s from *nucleotides*,
says the dreamer. ‘What is a *protein*?
How is it produced in the living cell?’ 42
‘A “*protein*” is a kind
of complex macromolecules
necessary for living. It is a very long 45

Song 4: Enzymes Read and Use the Genetic Information

chain, called “*polypeptide*,”
which is composed of twenty different
types of unitary molecules, called “*amino acid*” 48
“*residues*”; they are linked in
a *specific linear sequence*
via “*peptide bonds*” to form the “*polypeptide*.” 51
The linear sequence of
the various constituent amino acids
is the “*primary structure of a protein*.” 54
In normal physiological
conditions, the *polypeptide* chain folds
into a specific complex three-dimensional 57
structure, called “*conformation*.”
The specific biological function
of a protein is determined by its unique 60

Song 4: Enzymes Read and Use the Genetic Information

“*conformational structure*”.

According to their *conformations*,
proteins are classified into three classes: 63

The “*globular proteins*”
are soluble, and they work as *enzymes*.

The “*fibrous proteins*” are insoluble, and 66
they form stable structures.

The “*membrane proteins*” form
specific “*receptors or channels*” for control 69
of material exchanges

across the *cell membrane*.’ ‘If so,
the protein’s function must be determined 72

by the specific linear
sequence of its constituent units!’

interrupts Dante in sheer excitements, 75

Song 4: *Enzymes Read and Use the Genetic Information*

I wish to know whether
there are causative relationships
between the linear sequence of nucleotides 78
in DNA, which specifies
its genetic information, and
the linear sequence of amino acids 81
in the protein which endows
its particular biological function.’
‘Yes, Dante! The two sequences are “*co-linear* 84
with causative relationships.”
The *genetic information*, inscribed
by the specific linear sequence of the four 87
types of nucleotides along
DNA determines the *corresponding*
linear sequence of the twenty types of amino 90

Song 4: Enzymes Read and Use the Genetic Information

acids during the synthesis
of a *polypeptide*, which will fold
to obtain its “*functional conformation*.” 93

Hence, the *genetic information*,
inscribed along the DNA, *prescribes*
the *specific function* of the synthesized 96

protein under the normal
conditions of a living cell,’
says the dreamer. After deep reflections 99

Dante speaks: ‘The proteins
are the active agents that must make
themselves to carry out the intricate 102

complex affairs of living
in a cell. But they must work in
accord with the genetic instructions 105

Song 4: Enzymes Read and Use the Genetic Information

prescribed in the book of life.
If so, a particular protein must
be able to read the genetic information, 108
written in DNA,
and use it correctly in making
new proteins. If my guesses are correct, 111
I wish to know how such
exquisite, intelligent events
could actually occur in a living cell,' 114
says Dante in excitement.
'The linear sequence of nucleotides
along DNA is "*translated*" into its corresponding 117
co-linear sequence of
amino acids in proteins as follows:
The specific regions of DNA, called "*genes*" 120

Song 4: Enzymes Read and Use the Genetic Information

or “*coding regions*” are
first “*transcribed*” into a single-stranded
polynucleotide, called “*ribonucleic acid*” (RNA). 123

RNA is composed of
a linear sequence of four type
of nucleotides like DNA, but the base 126
thymine [T] is replaced
by a similar base uracil [U]
in RNA. [U] pairs with [A] as [T] does. 129

The synthesis of RNA strand,
known as “*DNA-transcription*”,
proceeds as follows: One of the two strands 132
of DNA is exposed
as a “*template*” for the synthesis
of its “*complementary base-pairing RNA*” strand 135

Song 4: Enzymes Read and Use the Genetic Information

by an enzyme, called
“*DNA-directed RNA polymerase.*”
When the “*transcription of the coding segment*” 138
of DNA” into its
corresponding complementary
RNA strand is completed, the DNA 141
restores its double-helical
structure. The newly synthesized
RNA strand, called “*pre-messenger RNA,*” 144
is released in the nucleus
of the cell. The molecular processes
of “*DNA transcriptions*” are regulated 147
by orderly and complex
mechanisms that determine which
“*coding segments*” of DNA are to be copied 150

Song 4: Enzymes Read and Use the Genetic Information

into “*RNA-transcripts*”
at various living conditions.
Other types of *proteins* modify these *RNA-* 153
transcripts. Thus edited, they
are exported from the *nucleus* to
the *cytoplasm* of the cell; they are called 156
“*messenger-RNA*”
[m-RNA]. The linear sequence
of nucleotides along a [m-RNA] 159
is read in terms of sets
of *three nucleotides*: each one
of the twenty types of amino acids is 162
matched to their corresponding
nucleotide-triplets, called “*codons*,”
mediated by an “*adaptor molecule*,” 165

Song 4: Enzymes Read and Use the Genetic Information

called “*transfer RNA*”
[t-RNA]: amino acids are
attached to various t-RNAs, each 168
of which recognizes
a “*codon*” in [m-RNA] by
“*complementary base-pairing interactions.*” 171
The “*genetic code*” has
been the *universal grammar*, used
by all organisms in the long history of life.’ 174
‘Hold it!’ *interrupts Dante*,
‘You must have an intriguing and
exciting drama of life, played by vital 177
molecules. But I cannot
follow it as you have unfolded.
Please make it concrete and clear for me 180

Song 4: *Enzymes Read and Use the Genetic Information*

to grasp it as much as
it may be feasible.’ ‘Help me, Dante!’
says the dreamer with honest plead. ‘Let us 183
go back to the beginning.
If the DNA is such an enormous
book, how an enzyme can choose which relevant 186
part of the DNA to read,
and then use it?’ *asks Dante.* ‘I see
what you are pointing to. I will try it, again.’ 186

Song 5

***The Molecular Drama
of Gene Expression.***

Song 5: *The Molecular Drama of Gene Expression*

‘There are various proteins,
called “*transcription factors*,” each
of which can *recognize* a specific linear
sequence of base-pairs
along DNA, and *binds* to
the particular DNA site and *regulates*
the “*rate of transcription*”
of the particular genetic
information from the DNA site
onto its corresponding
messenger-RNA. Each “*transcription*
factor” regulates to turn on or off specific
gene-expression in cells
so that they adjust to the changing
conditions in complex processes of living,’

3
6
9
12
15

Song 5: *The Molecular Drama of Gene Expression*

says the dreamer. ‘Now, I
can see the crucial actors. Tell me
what vital roles they play out in the drama,’ 18
says Dante in delight.
‘DNA has many specific
regions, called “*enhancers* or *promoters*,” 21
where the “*initiation of*
transcription of a gene” may occur.
A *promoter* region contains specific 24
DNA sequences, called
“*response elements*,” to which
“*transcription factors*” bind to regulate 27
transcription. The *factors*
which activate an initial binding
sites for the *RNA-polymerase* to begin 30

Song 5: *The Molecular Drama of Gene Expression*

the transcription of
that DNA segment are called
“*activators*.” “*Repressors*” are transcription 33
factors which inhibit
transcription of one or more *genes*
by blocking the attachment of *RNA-polymerase* 36
to the promoter sites
of DNA,’ *says the dreamer*.
‘Now, we have the protagonists and their 39
antagonists in the play.
What vital episodes do they play out?’
asks Dante. ‘Let me emphasize the crucial 42
fact that a “*transcription*
factor” is not an autocrat, which
dictates the control of transcription, at all. 45

Song 5: The Molecular Drama of Gene Expression

It merely regulates
in cooperation with many other
factors, according to various vital 48
signals of the on-going
living conditions, received from
many other cells of an organism in 51
its ever-changing environment,’
says the dreamer. ‘I see your point.
The episodes of the drama of life must be 54
much more intricate and
complex than any play I have read,’
says Dante, beaming warm smile. ‘First of all, 57
the number of actors
in this play is huge: Scientists estimate
that there are about two thousand and six hundred 60

Song 5: *The Molecular Drama of Gene Expression*

different types of “*DNA-binding proteins*”, which play as various “*transcription factors*” in humans. 63

Appropriate use of various combinations out of the large number of *transcription factors* in the “*differential regulations of transcription*” 66

of *various genes*” makes it possible for an organism during its *embryonic development* to build 69

its specific body-form, determine the fate of each cell according to various signals to attain its 72

unique morphology and specific functions within a given organism. 75

Song 5: The Molecular Drama of Gene Expression

For example, a family
of transcription factors, called “*Hox-TF*,”
regulates a group of related genes which 78
specify the design
of the body’s layout in an embryo:
“*Hox genes*” encode and specify the *body-* 81
positions such that proper
structures form in the appropriate
places within the whole body,’ *says the dreamer.* 84
‘It reminds me of
the miraculous and orderly
migrations of countless cells to construct 87
the exquisite unique form
of every individual organism,
and of the determination of the *fate map*, 90

Song 5: *The Molecular Drama of Gene Expression*

according to the position
of each cell within the embryo.
The actors, called *transcription factors*, must be 93
the actual performers
which carry out routinely such
marvellous and miraculous tasks in accord with 96
the laws of nature!’ *says*
Dante in sheer excitements. ‘Yes.
But a *transcription factor* is just a *protein* 99
that must be synthesized
by the transcription of a Hox gene
which encodes it, and thus the production 102
of the protein. Any changes,
called “*mutations*,” in the DNA-
sequence of a *Hox gene* can gravely affect 105

Song 5: *The Molecular Drama of Gene Expression*

the functions of the altered
transcription factor. “*Hox proteins*”
specify the appropriate *morphogenetic* 108
distribution of various
parts of the body. Mutations in
the *Hox genes* can result in malfunctions 111
of their corresponding *mutated*
transcription factors such that parts
of the body are misplaced in its layout. 114
Another important
example of the *family*
of transcription factors, called “*FOXP2-TF*” 117
is involved in the normal
embryonic development of the brain
in humans. “*Forkhead box protein P2*” 120

Song 5: The Molecular Drama of Gene Expression

is a family of
transcription factors, which is
encoded by the “*FOXP2-gene*”, located 123
on the human “*Chromosome 7*”.
It is involved in the appropriate
development of speech and language; we will 126
discuss about it later.
The *FOXP2-gene* is shared with
many other vertebrates; it is commonly 129
involved in the development
of communicative activities such
as singing specific songs in the songbirds. 132
Mutations of *FOXP2-gene*
in humans cause a severe speech
and language disorder, called “*developmental* 135

Song 5: The Molecular Drama of Gene Expression

verbal dyspraxia”.

Mutations of the homologous
FOXP2 gene in the songbirds impair 138
normal development of
birdsongs for their proper communication.
Exciting researches in this field are actively 141
in progress; what I have
babbled is merely a provisional
preamble to a wondrous story of life, 144
yet to be unfolded,’ *confesses*
the dreamer. ‘Everything in life
is so intricately and intimately inter- 147
connected!’ *whispers Dante*
to himself, elated in awe and
wonder. A silence prevails the dark woods, 150

Song 5: *The Molecular Drama of Gene Expression*

while they are immersed in
their profound thoughts. At last, Dante
breaks the silence: ‘Let us move on to the next 153
episode in your complex,
abstruse, and yet deeply fascinating,
and strangely moving story of mysterious life.’ 156

Song 6

*Editing and Using
the Genetic Information*

Song 6: Editing and Using the Genetic Information

‘When the living conditions
send signals which enhance *activators*
to bind to the *response element* of 3
the *promoter* site of
DNA, or inhibit *repressors*,
then the enzyme, called “*DNA-directed* 6
RNA polymerase,” binds
to the *promoter region* of DNA
and begins to *use its genetic information*: 9
The bound *RNA polymerase*
unwinds the local double-helical
strands of DNA such that only one strand 12
of the exposed sequence
of nucleotides can be used as
a template for the synthesis of its 15

Song 6: Editing and Using the Genetic Information

corresponding, *complementary*
single-strand RNA, called “*primary*
transcript”. There are several types of “*RNA* 18
polymerases”, which produce
different kinds of *primary transcripts*:
The “*RNA polymerase II*” synthesizes 21
the “*pre-messenger RNA*,”
which are variously modified
to become the *messenger RNA* [mRNA]. 24
Then, [mRNA’s] are
exported from the nucleus to
the cytoplasm so that they can be used 27
as *templates* for production
of their corresponding *proteins* at
the cytoplasmic structures, called “*ribosomes*.” 30

Song 6: Editing and Using the Genetic Information

The “*RNA polymerase I*”
produces functionally different
“*rRNA*, ” which are the precursors of 33
various RNA components
of the “*ribosomes*. ” The “*RNA*
polymerase III” synthesizes the “*transfer* 36
RNA”, which transfers
each type of amino acid to
a growing polypeptide chain at the site 39
which discerns the “*matching*
nucleotide-pairing in the ribosome”
during the production of protein, called 42
“*translation*, ” says the dreamer.
‘It is too confusing for me
to grasp: If the newly produced *primary* 45

Song 6: Editing and Using the Genetic Information

RNA transcripts are
variously modified before they
can be appropriately used, then the content 48
of their edited text must be
quite different from the original
version inscribed in the DNA. If so, 51
who is the bold editor?
Why does it alter the original
text of the sacred book of life—DNA?’ 54
asks Dante seriously.
‘I appreciate your insightful
questions. A “*protein-coding segment*” of 57
the human DNA has
many distinct nucleotide-sequences,
called “*DNA-introns.*” The corresponding 60

Song 6: Editing and Using the Genetic Information

sequences in the “*primary RNA transcript*”, called “*RNA-introns*”, are removed via complex *catabolic processes*, called “*RNA splicing*,” which convert a “*precursor messenger RNA*” into the final product of [mRNA]. 63

When all non-coding parts (RNA introns) are removed from a primary RNA transcript, the remaining coding regions, called “*exons*,” are joined together to produce a “*protein-encoding messenger RNA*. ” 66

‘I wonder what biological roles the useless *introns*, which must be removed by their intricate splicing, 69

72

75

Song 6: Editing and Using the Genetic Information

may play in the drama
of life,' says *Dante in pensive*
stance. 'The juxtapositions of coding *exons* 78
and non-coding *introns* make
possible to *splice them differentially*
such that a "*single gene*" may code for "*many* 81
different proteins."

Various modes of differential splicing
can arrange individual *exons* in different 84
linear sequences. In the *gene*
regulatory processes, called "*exon*
skipping", particular exons of a gene 87
may be selectively
included within or excluded from
the final production of the *messenger RNA's*. 90

Song 6: Editing and Using the Genetic Information

Splicing of each “*pre-mRNA*”
is performed by a group of enzymes,
called “*small nuclear ribonucleoproteins*” 93
[snRNP], which remove
introns at a complex structure,
called “*spliceosome*.” The splicing is regulated 96
by many “*splicing factors*,”
which either activate or inhibit
according to the biological conditions. 99
The detailed biochemical
mechanisms for the intricate editing
of the book of life are beyond my ken,’ 102
says the dreamer. ‘It seems
to me a creative rewriting
of a text into its many useful variations 105

Song 6: Editing and Using the Genetic Information

to meet the necessity
of ever-changing situations
of the living organism. I do admire 108
such exquisite mutual
regulations at various levels
in so many subtly interrelated events 111
in the drama of life!’
says Dante with heartfelt enthusiasm.
‘Use of genetic information for production 114
of various vital proteins
occurs at the “ribosomes” in
the cytoplasm. Each [mRNA] serves as 117
the template for synthesis
of polypeptide, made of amino acids,
in the orderly processes, called “translation”:

120

Song 6: Editing and Using the Genetic Information

The “*translation*” occurs
in accord with a set of rules,
called the “*genetic code*”: The [mRNA] 123
template is read in terms of
three-nucleotide units, called “*codons*”,
at a time by their base-pairing “*anticodons*,” 126
located on the “*transfer RNA*”
which carries the specific amino
acid residue that corresponds to each 129
particular “*anticodon*.”
Translation begins at a chain-
initiation codon on the [mRNA], 132
called “*start codon*,” when it is
activated by “*initiation factors*,”
which bind to small subunits of the *ribosome*. 135

Song 6: Editing and Using the Genetic Information

The nucleotide-triplet
[AUG] which encodes the amino
acid “*methionine*” is the typical “*start codon*” 138
in most organisms.

In contrast, [UAG], [UGA], and
[UAA] are “*stop codons*”, which signal release 141
of the “*nascent polypeptide*”
from the *ribosome*: they do not code
any amino acid, because no cognate *tRNA* 144
has *anticodon* which will
form proper base-pairs with these *stop*
codons. Hence, the *released polypeptide* will 147
form the *primary structure*
of a protein. It can combine with
many other polypeptides to compose the final 150

Song 6: Editing and Using the Genetic Information

“conformational structure”
of a complex protein, which endows
the protein its specific biological functions,’ 153
says the dreamer. ‘I see.
It is a moving story about how life works.
I wonder how the book of life is passed down 156
from a cell to its progeny
such that the vital text is replicated
and preserved in every cell of an organism,’ 159
says Dante. ‘The double-
helical structure of DNA enables
that each strand can serve as a template 162
for “*replication of*
its genetic information.” Because
each strand of DNA contains its specific 165

Song 6: Editing and Using the Genetic Information

linear sequence of the four-
types of subunits which is exactly
complementary to that of its partner strand, 168
each strand can serve as
the template to synthesize a new
pair of identical DNA as follows: 171
A set of “*motor enzymes*,”
called “*helicase*,” unpacks *chromatins*
and unwinds the double-helical DNA into 174
separate single strands.
Then, an enzyme called “*DNA-*
directed DNA polymerase” synthesizes 177
DNA molecules, using
each unwound strand as a template,
and reading the template DNA for each 180

Song 6: Editing and Using the Genetic Information

nucleotide at a time,
and selecting its *matching*
nucleotide via the base-pairing mechanism. 183

Hence, the genetic information
is precisely replicated, and
transmitted to new daughter cells which have 186

the identical genome
as the *cell generation cycle*
proceeds,’ *says the dreamer.* ‘I appreciate 189

the elegant simplicity
of how life begets itself!’ *exclaims*
Dante elated in wonder. ‘This is the gist 192

of my story about what I
have learned so far about the mystery
of life at the molecular level,’ *says the dreamer.* 195

Song 6: *Editing and Using the Genetic Information*

‘It takes my breath away to
realize that I have been carrying
such a sacred, vital book of wisdom 198
within me, in accord with
which my body has been built by itself,
and I have led this awesome mystic journey 201
of life as a self-conscious
human being!’ *says Dante in awe.* 203

Song 7

Spontaneous Changes of the Genome

Song 7: Spontaneous Changes of the Genome

After long contemplations

Dante resumes the conversation:

‘Despite their overwhelming complexities 3
and vast diversities, all
organisms seem to live on
the universal principles of profound 6
simplicity and sublime
beauty which take my breath away in
wonders. If DNA carries the vital wisdom 9
of life, who is the wise
author that has created such a vital
and sacred text? As I understand DNA is 12
an inert book to be read
and used by other active agents:
Some proteins can read and transcribe the genetic 15

Song 7: *Spontaneous Changes of the Genome*

information from DNA
and other proteins use it to make
more proteins as prescribed by DNA. 18

If so, I wish to know
whether there are such intelligent
proteins that can produce creatively new 21
genetic information
into DNA, or not.’ ‘None
of proteins can create novel genetic 24
information,’ *says the dreamer*.
‘If it is true, then I wonder
what physical entity has composed 27
the crucial wisdom of life—
genetic information—in the concrete
structure of DNA,’ *says Dante in solemnity*. 30

Song 7: Spontaneous Changes of the Genome

*The dreamer keeps a silence,
musing in deep thoughts, and then he
confesses: ‘We do not know, Dante, how to* 33
*answer such a difficult
question on the origin of life, yet.’
‘According to the *First Book of Moses,** 36
*everything of the world,
including all living creatures,
was created by the omniscient as well* 39
*as omnipotent God,’ says
Dante. ‘I remember the Moses’s
impressive myth of creation by God.* 42
*But Moses’s *God* cannot
be a right or wrong answer to
our question as Moses did not explain, at all,* 45

Song 7: *Spontaneous Changes of the Genome*

how his *God* actually
created life or any other things.
Such an empty attribution to his *God* 48
seems to me an evasion
or abnegation of the very question
how the primordial living cells happened 51
to emerge on the young Earth
between three and four billion years ago,’
says the dreamer. ‘I see your point that any 54
argument of creation
by God is irrelevant to
the question. Then how scientists pursue to find 57
a right answer?’ *asks Dante*.
‘In 1858 “*Charles Darwin*” and
“*Alfred Wallace*” propounded the revolutionary 60

Song 7: Spontaneous Changes of the Genome

“Theory of evolution.”

They observed that offspring had
“*modified traits*” which differed from those 63
of their parents, and proposed
that those varieties, which happened to be
better adapted to the changing environment 66
and hence had a better
chance to contribute their offspring
to the population, should be selected for 69
survival through a long
period of many generations of
reproduction in the journey of life; 72
Such dynamic and intricate
processes of “*natural selections*”
eventually result in the gradual changes: 75

Song 7: Spontaneous Changes of the Genome

*“Evolution of the fit
population”* of organisms which
happened to acquire the fit traits for 78
adaptation to their changing
environments through many generations,’
says the dreamer. ‘What dose cause variations 81
of traits among offspring?’ *asks*
Dante. ‘Traits are prescribed by *genome*.
All variations of the observed traits are caused 84
by the spontaneous changes
in the genome; such changes occur
naturally, not by any intelligent design. 87
The “*natural selection*”
occurs for the changed genetic
information that enhances its possessors 90

Song 7: Spontaneous Changes of the Genome

to survive and contribute
their offspring to their population
by adaptation for changing environments,’ 93
says the dreamer with firm
confidence. ‘I see. Please explain
to me how such blind random processes of 96
trial and error could do
such miraculous and wondrous works
in this real world,’ *says Dante in solemnity.* 99
‘As for the possibility
of spontaneous formations of
various “*information-bearing macromolecules*” 102
during violent geological
changes of the planet Earth after
its birth about four and a half billion years ago, 105

Song 7: *Spontaneous Changes of the Genome*

I will try to discuss it,
much later. For now, I wish to
emphasize the “*intrinsic modifiability*” 108
of any existing *genome*
in the natural processes of living.
The *genome* is not a fixed static entity 111
like a finished old book.
It is a *dynamic process of life*,
which *undergoes continuous diverse changes* 114
according to ever-
changing conditions of various
levels of its environments: “*Radiations*” 117
and “*mutagenic chemicals*”
in its physical environment change
randomly its *nucleotide-components*, 120

Song 7: Spontaneous Changes of the Genome

which results in its “*mutations.*”
Significant changes of the genome
can occur by “*insertion*” or “*deletion*” 123
of various “*mobile segments*
of DNA”, called “*mobile genetic*
elements”. “*Retrotransposons*” are mobile 126
elements which can be
multiplied and *inserted* into
the same genome at various locations: 129
An *RNA transcript*
of the mobile DNA segment
is used as a template by “*reverse transcriptase*” 132
to produce many extra
copies of the DNA segment,
and insert them back to random locations 135

Song 7: *Spontaneous Changes of the Genome*

of the same genome.
Various “*deletion mutations*”
occur due to loss of DNA segments 138
by errors during DNA
replication, or in the complex
processes of “*chromosomal cross-over*,” which 141
result in “*recombination*”
of genetic information
via exchange of DNA segments by *cutting* 144
and *pasting* between different
organisms to procreate their offspring
so that they inherit the newly recombined 147
novel genome. Some DNA
segments such as “*plasmids*” and “*viral*
mobile elements” can be transferred from one 150

Song 7: *Spontaneous Changes of the Genome*

species to foreign species
horizontally via “*transfection.*”
Also, new genes can be formed via duplications 153
of an ancestral gene
and subsequent variant mutations
of its multiple copies in the genome. 156
Various recombination
of different parts of DNA can also
enrich the genetic information of each 159
organism,’ *says the dreamer.*
‘I’m overwhelmed to hear that the genome
is so venerable to many diverse accidents 162
in the journey of life.
Hence, my metaphor for it as a book
is quite improper. The genome must be regarded 165

Song 7: *Spontaneous Changes of the Genome*

as an “*on-going dance*
of life”, which moves in harmony
with ever-changing situations in the complex 168
processes of living,’ *exclaims*
Dante in awe. ‘Yes. The genetic
information is an *unfinished manuscript* 171
which has been revised via
various *unpredictable accidents*
in the long history of our Earth since about 174
four billion years ago,’ *says*
the dreamer in elation. ‘Do you
claim that its author is not an omniscient 177
deity, but mere *accidents*
by chance, what the ancient Greek
called *Fortuna*?’ *asks Dante*. ‘I believe that 180

Song 7: *Spontaneous Changes of the Genome*

it is nature that allows
the genome to evolve gradually
through the long span of time from its simple 183
and primitive to more
complex and elaborated form
via the long *trial-and-error* processes, 186
as Darwin and Wallace
propounded in their theory of
evolution via natural selections,' *confesses* 189
the heathen dreamer with
firm conviction. 'If so, I wonder
how a simple primitive form has evolved 192
to become a self-conscious
thinking organism like a human
whose brain looks deep into the mystery of 195

Song 7: *Spontaneous Changes of the Genome*

the very origin of life,
and of its own miraculous
coming forth on this Earth,' says *Dante rapt* 198
in deep thoughts. 'Primitive
organisms with simple structure
of single cell, called *prokaryotes*, evolved 201
to complex cells, called
eukaryotes, which have elaborated
internal organelles. Their DNA's are kept 204
inside the nucleus.
Its chemical energy is generated
by "*mitochondria*," which are presumed to be 207
the descendants of ancient
prokaryotic cells that managed
to live inside the *eukaryotic* cell in 210

Song 7: Spontaneous Changes of the Genome

a mutually beneficial
“*symbiosis,*” says the dreamer. ‘How
wondrous to learn that even single cells knew 213
to help each other to live
together in harmony,’ exclaims
Dante, in sheer surprise. ‘The most inspiring 216
event in the evolution
of higher organisms is their sexual
union to procreate their new offspring: 219
The genetic information
from each parent becomes recombined
to enhance its offspring to adapt much better 222
to its changing environment
so that they can prosper and procreate.
Such an advanced symbiosis at the social level 225

Song 7: Spontaneous Changes of the Genome

resulted in radical changes
in the very nature of evolution:
Sexual revolution of the evolution,' 228
says the dreamer earnestly.
Dante meditates rapt in a solitude,
and then speaks in reflective mood: 'All of us 231
carry our unique
manuscript of life that has been edited
for billions of years since the immemorial era. 234
It emerged on this Earth
by pure chance spontaneously, without
any intelligent author. It has been edited by 237
long empirical processes
of the evolution through countless
generations of organisms which have struggled 240

Song 7: Spontaneous Changes of the Genome

to win in harsh, severe
competitions for survival and
successful procreation of their offspring. 243

This is the sublime epic
inscribed on the sacred manuscript
of life in every cell of a living organism, 246

through the long journey of life,
whispers Dante to himself. ‘You’ve sung
of the pithy essence of the mysterious journey 249

of life on earth in such
a lucid, eloquent, and moving
poem, my revered poet, Dante,’ *says* 252

*the dreamer with heartfelt
appreciation.*

Song 8

Evolution of Diverse Organisms

Song 8: *Evolution of Diverse Organisms*

‘Your story seems to imply
that all organisms have evolved
from their primitive simpler ancestors, 3
despite their complex
diversities. If so, I wonder when
they began the long journey of our life, 6
and kept on procreating
their offspring from generations after
generations, and what crucial events have 9
actually happened in
the history of life,’ *says Dante*
with genuine curiosity. ‘The oldest traces 12
of primitive single-celled
“*micro-organisms,*” which had left
their imprints in rocks as fossils, so far 15

Song 8: *Evolution of Diverse Organisms*

discovered by scientists,
are estimated to be between four
and three and a half billion years old. 18

We do not know as yet when
and how the “*first organisms*” originated
spontaneously on this planet Earth which is 21
estimated to be formed

about four and a half billion years ago.
All known organisms on Earth are classified 24
into three major *domains*:

“*Bacteria*,” “*Archaea*,” and “*Eukarya*.”

Bacteria are unicellular micro-organisms 27
which are enclosed by cell-

walls but lack a nucleus and other
organelles. They are the most ubiquitously 30

Song 8: *Evolution of Diverse Organisms*

distributed organisms
which thrive in soil, water, and air,
as well as in animals and plants. They play 33
vital roles in dealing with
complex inter-relations among
organisms and their environments. *Archaea* 36
are micro-organisms
which are similar to *Bacteria*
in structure but radically different 39
in biochemical metabolisms.
Many kinds of *archaea* can thrive in
harsh environments such as vents of volcanoes 42
at deep dark ocean floors,
hot springs, salt lakes, and marshlands,
where *Bacteria* or *Eukarya* cannot survive. 45

Song 8: Evolution of Diverse Organisms

Some kinds of *archaea* live
in many other organisms, including
humans. *Eukarya* have the *nucleus* and 48
other *organelles*. There were
many kinds of *single-celled eukaryotic*
micro-organisms. About one and a half billion 51
years ago, more complex
“*multicellular organisms*” which were
composed of many cells that were integrated 54
into a whole, evolved
in *Eukarya*. They are the familiar
forms of life: Both “*Animal and Plant kingdoms*” 57
belong to *Eukarya*,
says the dreamer. ‘It is very hard
to imagine such an immense span of time. 60

Song 8: *Evolution of Diverse Organisms*

What evidence do you have
to prove that all organisms descended
from common ancestors, despite their drastic 63
differences?’ asks *Dante*.
‘Recent molecular comparisons
of many *diverse genomes* revealed that they 66
shared a set of three hundred
fifty-five “*common genes*”, regardless
whether they were sampled from *Bacteria*, 69
Archaea, or *Eukarya*.
Hence, the “*set of common genes*” is
inferred to have been passed down from an ancient 72
population of primitive,
unicellular, prokaryotic micro-
organisms, called “*last universal common* 75

Song 8: *Evolution of Diverse Organisms*

ancestor”, from which all
known organisms have evolved,’ says
the dreamer. ‘I see. When did the animals 78
emerge?’ asks *Dante*.
‘The oldest fossils of primordial
animals are about seven hundred million years old. 81
Since this crucial event,
the evolution progressed rapidly:
Between six and five hundred million years ago, 84
diverse kinds of “*algae*”
and “*invertebrate*” creatures prospered.
Then, “*primitive vertebrate fishes*” emerged 87
around four hundred fifty million
years ago. Between four and three hundred
fifty million years ago, “*amphibians*” and “*insects*” 90

Song 8: *Evolution of Diverse Organisms*

began to live on lands.
The fossil records reveal drastic
events of “*massive extinctions of organisms*” 93
due to catastrophic changes
in their environments. Three hundred
million years ago, many kinds of “*marine* 96
invertebrates” perished,’
says the dreamer. ‘What did cause
such drastic extinction of life?’ ‘The massive 99
movements of the continents
and the oceans on the surface
of Earth resulted in extreme changes in climate 102
as well as in their habitats.’
‘What? How could the continents move?’
interrupts Dante astonished with perplexity. 105

Song 8: Evolution of Diverse Organisms

‘Our planet “*Earth*” consists
of the “*solid inner core*,” “*liquid*
outer core” at very high temperatures, 108
and the thick enclosing
“*mantle layers*,” floating on the hot
liquid outer core. The rigid outermost shell 111
of the mantle layer,
called “*lithosphere*,” is composed of
separate “*tectonic plates*”: they move slowly, 114
floating on a viscous
and elastic underlying layer
of the upper mantle. The “*continental plates*” 117
covered by their crusts form
the “*terra firma*”; the “*oceanic*
plates” covered by their crusts contain waters 120

Song 8: Evolution of Diverse Organisms

which form various *oceans*.

The relative movements of these
tectonic plates result in massive changes: 123

If an *oceanic plate*
converges to a *continental plate*,
huge “*subductions*” occur along their boundary, 126
causing *earthquakes* and
volcanic eruptions. If these plates
diverge from each other, it causes to form 129
deeper “*oceanic trenches*. ”

If a *continental plate* collides with
another *continental plate*, it causes them 132
to heave up stupendous
mountain ranges, such as the Himalaya.

Dynamic movements of these *tectonic plates* 135

Song 8: *Evolution of Diverse Organisms*

formed “*super-continents*”
and “*super-oceans,*” and changed
them into separate continents and oceans 138
throughout the long history
of our Earth,’ *say the dreamer.*
‘It seems to me an incredible miracle 141
that fragile life survived
such awful trials of extreme
catastrophes!’ *says Dante in a sombre mood,* 144
‘How did humankind
happen to evolve so that we
can reflect, eventually, on the deep mystery 147
of our own adventurous
journey of life on this capricious
earth in darkly uncertainty?’ ‘Following 150

Song 8: *Evolution of Diverse Organisms*

the major extinction
of the marine invertebrates,
“reptiles” and “insects” prospered on the lands. 153
Giant reptiles called “dinosaurs”
dominated a *super-continent*,
called “*Pangaea*,” for a prolonged duration 156
of one hundred-thirty million
years long. *Pangaea* began to divide
into separate continents around one hundred 159
eighty million years ago;
It made a wide *dispersal of*
dinosaurs, inhabiting on several 162
drifting continents.
It promoted them to diversify
into many various kinds. Suddenly they 165

Song 8: *Evolution of Diverse Organisms*

suffered the catastrophic
extinction sixty-six million
years ago, which terminated very abruptly 168
their unprecedented long
dominance of the *terra firma*.’
‘What did cause such an abrupt and drastic 171
extinction?’ *interrupts*
Dante in stark surprise and
curiosity. ‘A huge “asteroid” from the space 174
struck Earth and formed vast
“impact-craters” around that period.
Such a cosmic accident may be the crucial 177
cause for the sudden
extinction of the predominant
dinosaurs,’ *says the dreamer. Dante muses* 180

Song 8: Evolution of Diverse Organisms

in deep thoughts, and speaks:

‘It takes my breath away to realize
that such an uncertain cosmic fortuity 183
 resulted in the crucial
changes in the course of the history
of life on the Earth. Tell me what happened 186
 next, and how it promoted
the eventual emergence of new
humankind.’ ‘After the abrupt extinction 189
 of dinosaurs, various kinds
of “*mammals*” and “*birds*” began
to prosper rapidly. Wild beasts such as 192
 lions, tigers, and bears
dominated the lands, and giant marine
mammals like “*whales*”, “*sea-lions*”, and “*dolphins*” 195

Song 8: *Evolution of Diverse Organisms*

ruled the oceans in time.
Then, “*anthropoid primates*” such as
“*monkeys*” and “*apes*” emerged in lush forests 198
about forty million years ago.
“*Gibbons*”, “*orangutans*”, “*gorillas*”,
and “*chimpanzees*” are the surviving kinds 201
of *apes* whose features and
behaviours resemble more closely
to those of the humans than any other 204
organisms, living now.’
‘Your fascinating story on journey
of life on earth implies that the organisms 207
tend to become more complex
as their journey on the Earth progresses
in time. As each organism must build itself 210

Song 8: *Evolution of Diverse Organisms*

in accord with its own
genome as you aver, I surmise
that the genomes of various organisms 213
must have undergone ahead
analogous changes from simpler
to more complex texts of proper instructions 216
which had enabled
the organisms to change their forms
left in fossils as they kept on procreating,' 219
says Dante in a pensive voice.
'Your insightful inference is right:
The genome of chimpanzees, our closest 222
living animal relative,
is very similar to ours with less than
four percent difference in "*DNA sequences.*" 225

Song 8: *Evolution of Diverse Organisms*

As the degree of differences
in their genomes increases, various kinds
of organisms diverge more in their characteristic 228
forms, functions, and behaviours.
The *DNA sequences* are modified
by “*re-combinations*”, “*mutations*”, and other 231
causes. These natural changes
in DNA are passed down to offspring,
and selected for the value of their fitness 234
for the survival and
procreation in ever-changing
environments. The populations with “*fit changes*” 237
prosper; those with “*harmful*
changes” extinct from the competitive
journey of life. Through the complex processes 240

Song 8: Evolution of Diverse Organisms

of “*natural selection*”
over the long period, a new genus
called “*Homo*” evolved eventually from 243
the unknown, now extinct
“*common ancestors*” of the current
“*anthropoids*” such as *gibbons*, *orangutans*, 246
gorillas, and *chimpanzees*.
The “*humans*” and the “*chimpanzees*”
may have diverged from their “*common* 249
ancestors” as recently
as only five million years ago. Hence,
the *emergence of humankind* in the long 252
history of life on Earth
is an extremely recent event.
This is a brief gist of the miraculous 255

Song 8: *Evolution of Diverse Organisms*

adventure of our life,
evolving on this unique planet
Earth through the immense period in the drama 258
of the mysterious universe,'
says the dreamer elated in awe. 260

Song 9

Emergence of Humankind

Song 9: *Emergence of Humankind*

Dante immerses in

a meditation, then speaks solemnly:

‘The natural evolution of life is a bold 3
yet breathtaking story
beyond my ken; I realize that
the whole history of humankind is very brief 6
like a point in the vast
span of time; yet it is the most
critical point in the long adventurous 9
journey of life. I urge
you to transfigure this point into
a moving epic: how it happened that 12
our ancestors arose here,
survived, and procreated us to look
into the deep mystery of our own origin.’ 15

Song 9: Emergence of Humankind

‘Such a great task is far
beyond my ability, Dante.
We do not know as yet how we have evolved 18
from our extinct unknown
“*primogenitors*.” But I am eager
to share with you whatever I have learnt 21
about our origin, although
they are mere provisional findings.
Fossils of bone fragments of various kinds 24
of extinct great apes, found
in Africa, suggest that they underwent
gradual yet radical changes from the “*quadrupedal*” 27
to the “*bipedal*” mode
of locomotion between five and two
million years ago; they attained the ability 30

Song 9: *Emergence of Humankind*

to *walk upright* as
the humans do. But their “*craniums*”
remained similar to those of the chimpanzees 33
in size and shape, unlike
those of the humans, even as late
as about two million years ago; they had “*mosaic* 36
anatomical features”.’
‘If so,’ *interrupts Dante*,
‘the ability to walk upright came 39
before that of thinking aright.
Walking would have freed their hands for
doing something useful with their handy hands, 42
I surmise.’ ‘We have not found
“*stone tools*” made by the various kinds
of *walking apes*, called “*Australopithecus*,” 45

Song 9: Emergence of Humankind

who lived in Africa
between five and two million years ago.
In contrast, various *stone tools* were found with 48
the fossil remains which
showed *larger cranium size* and
anatomical features more similar to ours: 51
The earliest of these tool-
makers, called “*Homo habilis*,”
had a larger brain than that of the latest 54
walking ape, “*Africanus*
robustus”, which co-existed with
Homo habilis around two million years ago. 57
Then a new species, called
“*Homo erectus*” emerged about
one and a half million years ago, and they 60

Song 9: *Emergence of Humankind*

lasted as recently as to
about three hundred thousand years ago.
They were taller and more robust than we with 63
large brains very similar
to ours. *Homo erectus* lived
in *caves* or *built their shelters*. They used animal 66
hides as clothes and improvised
many new useful stone tools. They were
the first humans who learned how to *handle fires* 69
for their various usage.
The most astounding task achieved
by *Homo erectus* was the vast “*expansion* 72
of their habitats.” They
took on adventurous *migrations*
from their small tropic habitats in Africa 75

Song 9: Emergence of Humankind

to new vast territories
of challenging strange environments.
Their fossils were found in diverse regions 78
of Asia and Europe.
Around five hundred thousand years ago,
a new species, called “*Homo sapience*” emerged. 81
The fossil-remains of
these archaic humans, found in
Africa, Europe, and Asia, show various 84
mosaic intermingled traits
of both the “*Homo erectus*”
and the “*anatomically modern humans.*” 87
The most available fossils
of these “*archaic humans,*” called
the “*Neanderthals,*” reveal that they lived from 90

Song 9: Emergence of Humankind

two hundred thousand to
forty thousand years ago across wide
ranges from the western and central Europe 93
to the central Asia.

The most remarkable features of
the *Neanderthals* is their advanced “*cranial* 96
capacity” which is as
large as that of the “*modern humans,*”
says the dreamer. ‘I wonder what these new 99
archaic humans with
such large brains achieved,’ *says Dante.*

‘The *Neanderthals* produced great variety 102
of tools made of animal
bones, as well as stones. They produced
beautiful *stone pendants* for their artistic use 105

Song 9: *Emergence of Humankind*

as personal ornaments
rather than for practical use
such as blades, hand axes, spears for hunting and 108
cutting. “*Red ochre*” and
other natural pigments were found
in their caves but their presumed works of art 111
did not survive the ravage
of time for us to witness. Some
of their remains show traces of burial. 114
They suggest the possibility
that the *Neanderthals* carried out
intentional *burials for the dead* of 117
their family and close kin.’
‘Tell me more about such sacred,
symbolic, and religious acts performed 120

Song 9: Emergence of Humankind

by our remote ancestors,’
exclaims Dante in sheer delight.

‘Scientists recovered many well-preserved 123
skeletal remains of
the *Neanderthals*, ranging from the old
in age to young infants; they were buried 126
in deliberately built
tombs in orderly arrangements
with presumed “grave goods” such as stone tools 129
and burnt animal bones.

It is impossible for us to know
whether they performed certain rites of burial 132
for their dead, and if they
did, for what symbolic significance.

But we have archeological traces which suggest 135

Song 9: *Emergence of Humankind*

that the *Neanderthals* had
the sociocultural tradition of
burial of the dead members of their family, 138
close kin, even of the tribe
to which they belonged to win in
the harsh, hard, dire struggles for survival 141
and procreation of
their offspring,' *says the dreamer*.
'These archaic humans must have believed, 144
I surmise, in something
spiritual beyond their temporary
journey of life. Such a devout belief should 147
have steered the mystic
voyage of our life through the deep
vast sea of being. I exalt their self-conscious 150

Song 9: Emergence of Humankind

wise mind as the very source
from which the spiritual rivers of
human civilizations have flown in time,' 153
says Dante in solemnity.
'The earliest fossils of the anatomically
modern humans, called "*Homo sapience sapience*," 156
are only two hundred
thousand years old. A small population
of these modern humans moved out of Africa 159
seventy thousand years ago.
They dispersed widely and inhabited
successfully the whole globe. By thirty thousand 162
years ago, eventually they
replaced then "*co-existing archaic*
humans" such as the *Neanderthals* and others, 165

Song 9: *Emergence of Humankind*

who became extinct from
the stark and severe struggles for
existence,' *says the dreamer*. 'I wonder 168
what features made us to
dominate the whole globe and create
our civilizations,' *says Dante*. 'I suppose 171
that our *creative brains*
and our *use of language* as well as
versatile hands made it possible to transcend 174
from the "*human-animals*"
to the intelligent *creators*
of our civilizations. Around ten thousand 177
years ago, the last cycle
of ice age ended and mild climate
blessed the "*anatomically modern humans*" 180

Song 9: *Emergence of Humankind*

to learn how to cultivate
crops and domesticate animals
for food and other important uses. 183

Their “*agricultural
revolution*” brought forth radical
changes: The “*hunter-gatherers*” who had lived 186
as egalitarian members
of small familial “*nomadic
bands*” were compelled to labour with strangers 189
in much larger “*settled
agricultural societies*” which
imposed them to abide severe “*social* 192
stratifications” into
the rich, powerful “*ruling classes*”
versus the poor, helpless “*subjugated classes*. 195

Song 9: Emergence of Humankind

I surmise that primitive
“*agricultural chiefdoms*” fought to
subdue each other, and eventually the winner 198
established a unified “*state*,”
says the dreamer. ‘Do you think that
the “*theocracy*” was a crucial invention 201
to achieve a monarchy?’
asks Dante. ‘Yes. The cradles
of the “*ancient civilizations*” that arose 204
in Mesopotamia,
Egypt, India, and China, between
six and five thousand years ago, were all 207
theocratic monarchies!’
says the dreamer resolutely. 209

Song 10

*Artistic Creativity
of Early Humans*

Song 10: *Artistic Creativity of Early Humans*

*Eloquent silence prevails
in the dark woods while Dante and
the dreamer wander into their private thoughts.* 3

*At last, Dante speaks in
solemnity: ‘You avow that it is
humans who have conjured up their fanciful* 6
*deities and worshiped them
as if they had created and ruled
all creatures with their absolute powers* 9
*and will. If so, why did
the humans make up such hoax “gods,”
and worship them so sincerely with utmost* 12
*devotion?’ ‘I do not know
the real reasons, Dante. I surmise
that the humans have an innate need and desire* 15

Song 10: *Artistic Creativity of Early Humans*

to worship their private
spirituality which they can not
perceive directly but deeply revere 18
in awe and wonder.

During the long “*prehistoric era*,”
the early humans left faint but concrete 21
traces of their mystic
spiritual feelings which we can
recognize and appreciate almost 24
forty thousand years later,’
says the dreamer in awe and wonder.

‘What are concrete evidences for such private 27
and mystic beliefs in
the sacred spirituality, revered
by our primitive ancient ancestors?’ 30

Song 10: *Artistic Creativity of Early Humans*

asks Dante in surprise.

‘Scientists found over three hundred
caves which preserved ancient prehistoric 33
works of arts, created by
our immemorial ancient ancestors.
The most important and astounding 36
recent discovery, I think,
is the paintings on the walls deep
in the “*Chauvet Cave*” in France: this extensive 39
darkly labyrinth has
very intricate and awesome
configurations which inspire breathtaking 42
awe and wonder to any
sentient beings. Some parts of its walls
show scratches left by now-extinct *cave-bears* 45

Song 10: *Artistic Creativity of Early Humans*

which occupied the cave
for hibernation, long before
any humans happened to find it. 48

On its elongated floors,
skulls, bones, and footprints of cave-bears,
ibex, and wolves are scattered. But there is 51

no trace of everyday
living of humans in the cave
as their permanent dwelling home; the only 54

traces left in the cave by
the humans are marks of soot from
burning torches, they used to illuminate 57

the dark deep cave, and fading
footprints of a human child. These facts
suggest that the cave was used by the humans 60

Song 10: *Artistic Creativity of Early Humans*

as a *sacred sanctum*
for their *artistic expressions*
rather than as a commonplace of their habitation. 63

The oldest depictions
of animal figures preserved on
the cave walls were drawn or painted in black: 66

They are estimated to be
about thirty-five thousand years old; thus
attributed to the “*Aurignacian culture*” of 69

“*European Early Modern*
Humans” in the “*Upper Palaeo-*
lithic” era. Then another group of early 72

humans happened to discover
the same cave about five thousand years
later: these new visitors, called “*Gravettian,*” 75

Song 10: *Artistic Creativity of Early Humans*

contributed their artistic
visions by creating super-
imposing figures in red over the pre- 78
existing old artworks,
as well as adding their new artworks.
Most paintings show vivid vibrant figures 81
of wild animals: lions, mammoths,
rhinoceroses, cave-bears, panther, horses,
bison, ibex, reindeer, auroch, oxen, and owl. 84
The “*Chauvet cave*” also contains
various abstract and abstruse “*signs*”
in conjunction with the many vivid figures. 87
What these signs may denote
remains as an enigma. There is only
one strange depiction of humans: a woman’s 90

Song 10: *Artistic Creativity of Early Humans*

reproductive organ,
in conjunction with a “*zoomorphic*”
composite figure of an imaginary man 93
with a bison’s head.’ ‘What?’
interrupts Dante in a surprise,
‘How could the primitive artist conjure up 96
such an imaginary creature
which he had never seen?’ ‘It is
very puzzling enigmas, also left by other 99
prehistoric artists:
An ivory sculpture of “*lion-*
headed human”, called “*Lowenmensch*,” was 102
discovered at Hohenstein-
Stadel cave in Germany; it is
the oldest known “*zoomorphic sculpture*,” 105

Song 10: *Artistic Creativity of Early Humans*

estimated to be about forty
thousand years old, and attributed to
the “*Aurignacian culture*.” Scientists also found 108
ancient “*Aurignacian flutes*”
in Geissenklosterle cave, Germany;
They were estimated to be about forty-three 111
thousand years old. Another
Aurignacian cave in Hohle Fels,
Germany, revealed a “*Venus figurine*” made of 114
mammoth ivory, known as
“*Venus of Hohle Fels*,” and a flute
made from a vulture’s wing bone; it was 117
perforated with five finger holes.
Hence, the *Aurignacian* culture had
enjoyed music as well as symbolic arts, 120

Song 10: *Artistic Creativity of Early Humans*

in spite of their very harsh
living conditions during the long,
severe “ice age,” I surmise,’ *says the dreamer.* 123

‘Although I have never seen
their works of art, the artistic
creativity of our remote ancestors 126

moves me deeply. What does
their art imply to us? Why did they
toil to create such arts?’ *whispers Dante* 129
to himself in wonder.

‘I am not qualified to make
any scholarly interpretation of their art. 132

But I wish to discuss
with you a moving narrative
depiction of a “fallen man with bird’s head” 135

Song 10: *Artistic Creativity of Early Humans*

at the “*Shaft chamber*” in
the “*Lascaux Cave*” in France: it is
estimated to be about seventeen thousand years old, 138
and attributed to
the “*Magdalenian culture*,” “Tell me
the narrative depiction and why it moved you,” 141
says Dante. ‘At the center
lies a sketchy caricature of a fallen
helpless man with a strange bird-shaped head. 144
On his immediate right side,
a vigorous, enraged, and powerful
bison was so realistically depicted. 147
The lively bison looks
about to attack the man, or has knocked
him down. A long shaft with a sharp barb was drawn 150

Song 10: *Artistic Creativity of Early Humans*

across the hind part of
the bison, as if it had pierced it.
Immediately below the right hand of the man, 153
a sketch of a *“bird perched
at the top of a pole”* was drawn.
It looked to be an obelisk or a symbol 156
for *“memorial of the dead”*
rather than a depiction of
a real bird. Between the *“bird-pole”* and 159
the *“right foot of the man,”*
a *“shorter shaft with a barb,”* or a sign
for *“spear”* or *“wounded,”* was drawn parallel to 162
the layout of the fallen man,
says the dreamer in sheer excitement.
‘I concur with you that it is a genuinely 165

Song 10: Artistic Creativity of Early Humans

moving narrative depiction!
Now, tell me what you dream up
from the ageless work of art,' says *Dante*. 168
 'The impressive painting
seems to speak in a mysterious
and eloquent voice to its beholders in awe: 171
 "*A man encounters a giant
bison. He wields his weapon to
conquer the mighty opponent. His spear pierces 174
the bison, but it fails
to defeat the powerful giant.
The enraged bison attacks the man and knocks 177
him out. The mortally
wounded man falls to the ground; he
meets his death, looking at the awesome bison.* 180

Song 10: *Artistic Creativity of Early Humans*

Behold the sacred “ba”
which emerges from the body of
the dying man!”” says the dreamer in awe. 183

‘I like your imaginative
innovation of the mystic voice
of the story-telling painting. What do you mean 186
by the sacred “ba”?’ asks
Dante. ‘It depends on many provisional
assumptions: First, I presume that the sketch 189
of “bird-pole” is a symbol,
not a depiction of a real bird
perching on a pole; it looks to me very 192
similar to the early
Egyptian hieroglyph of
a “bird’s profile,” pronounced “ba”; As for 195

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the Egyptian's concept
of their word "*ba*," it is too abstruse
for me to comprehend definitely: it may 198
imply something like what
our words "*soul*", "*spirit*", and "*ghost*", may
suggest, but I do know what they really mean. 201
I feel that the prehistoric
artists were inspired by their own
"*inner spirituality*" to express what 204
they thought, how they felt, what
they imagined and wished in solitude.
The awe-inspiring deep caves were their *sacred* 207
private sanctum, in which
they expressed their "*inner spirituality*"
by means of painting in profound solitude, 210

Song 10: *Artistic Creativity of Early Humans*

I believe,' *confesses*
the dreamer in awe and wonder.

'Private art of spirituality,' *whispers* 213
Dante to himself.

'I wish to express my naïve yet
honest feelings about the mysterious 216
private art in the "*Chauvet*
cave": The depicted figures are simple
and sketchy; yet they look so vividly alive 219
with vibrant mysterious
vitality. Each figure seems to breathe
out its own spirit, as if it were pervading 222
the awesome architecture
of the cave and invoking the sacred,
sublime, and ineffable spirituality 225

Song 10: *Artistic Creativity of Early Humans*

in eloquent silence.
It is truly an astounding fact
that the primitive early human beings 228
achieved such miraculous
timeless arts of the sublime and
sacred spirituality in utter solitude,' 231
exclaims the dreamer rapt in
elation. 'How deep I wish to see
such a true art of intimate private 234
spirituality,' *says*
Dante. 'I think that these true arts
attest the sacred "*inner spirituality*" 237
which is inherent in
humanity: it precedes by almost
thirty-thousand years the emergence of 240

Song 10: *Artistic Creativity of Early Humans*

various *institutionalized*
state-religions, invented by rulers
and priests to unify and govern many diverse 243
peoples in their complex
large societies, which began only
seven thousand years ago,' *says the dreamer.* 246
 'I see. I'm delighted to hear
that you believe in such spirituality
of the art. I wonder how you would 249
 distinguish it from "*soul*,"
which you deny its reality,' *says*
Dante. 'I think that the "*spirituality*" 252
 of any human work is
the product of one's creative brain,
which may survive the fleeing human life, 255

Song 10: *Artistic Creativity of Early Humans*

as long as there are other
humans who can appreciate the work.’
‘Then, do you believe that there exists 258
immortal spirituality
in each work of true art?’ *asks Dante.*
‘Yes, I do. I wish to learn how artists 261
and poets have created such
sublime spirituality in their works,
which survive long after their fragile brains 264
have perished into dusts,’
says the dreamer in awe and wonder. 266

Song 11

***Functional Organization
of the Human Brain***

Song 11: *Functional Organization of Human Brain*

‘You assert that the human
brains are the creative agents
which produce all works of true art; and that 3
the brains of other humans
can be the active agents which may
recognize the timeless spirituality 6
of others’ works. If so,
I wonder what concrete features
of the human brain have enabled it to 9
create such wondrous works
of art, and to recognize the abstract
spirituality of other human brains,’ 12
says Dante in solemnity.
‘It is the most profound mystery
which eludes the wit and ken of my poor brain. 15

Song 11: *Functional Organization of Human Brain*

Although its versatile
functions are utterly mysterious,
the human brain is a definite organ: 18

When it is taken out
of the skull for a post-mortem
examination, it looks like a wrinkled, jelly, 21

grey pumpkin. The human
brain has very intricate cellular
architectures but it is quite similar 24

to those of other living
primates. It is mapped into many
parts with an anatomical name, given 27

by humans as they used
to demark a country into many
regions, each called by a geographical name,' 30

Song 11: *Functional Organization of Human Brain*

says the dreamer. ‘Lead ahead.
I wish to take an informative tour
of the strange realm of the brain in my head,’ 33
says Dante with interest.
The dreamer takes out a sheet
of paper from his pocket and acts out, 36
as if he were a magician:
‘Let us pretend that this sheet is
the “*neural plate.*”’ ‘Yes. It must be the part 39
of ectoderm, which was
induced to become the provenance
of the whole nervous system as you told,’ 42
said Dante. ‘The *neural plate*
folds; then its two lateral edges fuse
to form the “*neural tube.*” About four-weeks 45

Song 11: Functional Organization of Human Brain

after the fertilization,
the *neural tube* forms the “*primary*
brain vesicles”: “*forebrain*” at the front, 48
“*midbrain*” in the middle,
and “*hindbrain*” behind. The long
narrow caudal part of the same *neural tube* 51
develops to become
the “*spinal cord*.” The *forebrain*
develops into two “*secondary brain vesicles*”: 54
“*Telencephalon*” and
“*Diencephalon*.” The *midbrain*
remains as “*Mesencephalon*.” The *hindbrain* 57
develops into two
secondary brain vesicles: “*Met-*
encephalon” and “*Myelencephalon*.” 60

Song 11: Functional Organization of Human Brain

*The dreamer sketches them on
the paper. ‘I see. What these five
secondary brain vesicles develop into?’* 63
*asks Dante. ‘The telencephalon
enlarges enormously to become
the “cerebrum”; Diencephalon develops* 66
*into “thalamus”,
“hypothalamus”, and “epi-
thalamus”. The mesencephalon develops* 69
*into various midbrain
structures. The metencephalon forms
“pons” and “cerebellum.” The myelencephalon* 72
*becomes “medulla
oblongata.” All these structures
are directly observable in a dissected* 75

Song 11: *Functional Organization of Human Brain*

adult brain.’ ‘I wonder what
these structures do in your brain and
in my brain, which enable us to converse 78
about them right now,’ says *Dante*.
‘I do not know, yet one may guess
some plausible neural events as follows: 81
The *cerebrum* is the most
prominent structure which consists
of the “*cerebral cortex*” and other “*sub-* 84
cortical neural structures.”
The *cerebral cortex* is the center
which integrates various neural information. 87
It carries out complex neural
processing, which are involved in
“*perception*” of various “*stimuli*”, “*attention*”, 90

Song 11: *Functional Organization of Human Brain*

“*execution of willful*
movements” of various parts of the body,
“*thinking,*” “*planning,*” and “*communicating*” 93
with other human brains
by the use of a “*language,*” as
we are doing now,’ *says the dreamer.* 96
‘It sounds fascinating.
But how do you know these subtle
matters?’ *asks Dante with sincere curiosity.* 99
‘We merely conjecture them
in negative ways: When a specific
region of the *cerebral cortex* is damaged 102
by injury or disease,
the patient loses a particular
corresponding neurological function. 105

Song 11: *Functional Organization of Human Brain*

For example, a damage
of a specific cortical region
results in a loss of speech, which was first 108
documented in an ancient
Egyptian surgical papyrus
four thousand years ago.’ ‘What?’ *interrupts* 111
Dante in excitement,
‘Show me the very site on your drawing
of the cerebral cortex.’ ‘It is divided 114
into the left and the right
“*cerebral hemispheres*” which are inter-
connected via “*commissures*” across the midline. 117
Each hemisphere is demarcated
into four main “*lobes*”, named “*frontal*”,
“*parietal*”, “*occipital*”, and “*temporal lobe*”. 120

Song 11: *Functional Organization of Human Brain*

These different regions
of the *cerebral cortex* are involved
in performing their specific neural functions: 123

If the *occipital lobe*
in the right hemisphere is damaged,
the patient becomes blind to the left half 126
of his or her visual field.

If the *parietal lobe* in the left
hemisphere is damaged, the patient losses 129
sensation from the right side
of the body. If this posterior
part of the *frontal lobe* in the right hemi- 132
sphere is damaged, the patient
losses the ability to control
the left side of the body. But a damage to 135

Song 11: Functional Organization of Human Brain

the anterior part of the same
frontal lobe impedes “*abstract mental*
functions,” such as “*thinking*” and “*planning.*” 138

If this upper central part
of the *temporal lobe* is damaged,
the patient becomes deaf.’ ‘I see. What happens, 141

if other parts of the same
temporal lobe are damaged?’ *asks*
Dante. ‘It will result in impairment 144

of various cognitive
functions, such as remembering
things, events, and one’s own experiences. 147

Damage of this part (called
“*Wernicke’s area*”) of the *temporal*
lobe in the left *cerebral hemisphere* causes 150

Song 11: *Functional Organization of Human Brain*

the patient to lose
the ability to comprehend
the meaning of utterances, heard from other 153
speakers, although the patient
retains the ability to speak.
In contrast, if this part of the *frontal lobe* 156
(called “*Broca’s area*”) is damaged,
the patient loses the ability
to produce utterances,’ *says the dreamer.* 159
‘It is fascinating.
Are you asserting that speaking
and understanding speech are performed by 162
these two separate structures
in the left cerebral hemisphere?’ *asks*
Dante. ‘They are discrete neural structures 165

Song 11: *Functional Organization of Human Brain*

which are interconnected
anatomically as well as
functionally. This is an ad hoc tour 168
of the main functional
organization of the *cerebral*
cortex in the *cerebrum* of the human brain. 171
They are based on the results
of clinical observations from
many neurological patients, which imply 174
merely that these neural
structures may be involved in
carrying out the specific neural functions. 177
But we know very little
about the scientific mechanisms
how these neural structures carry out such 180

Song 11: *Functional Organization of Human Brain*

mysterious and specific
cognitive functions in terms of
a very larger number of intricately 183
interconnected cells,
called “*neurons,*”” says *the dreamer*. 185

Song 12

Neurons and their Functional Synaptic Networks

Song 12: *Neurons and their Synaptic Networks*

‘Thank you for the fascinating
and revealing tour of the human brain.
My brain appreciates the sincere, prudent, 3
and honest attitude
of your brain concerning how
human brains can perform such mysterious and 6
wondrous mental functions
as we have been conversing on
this abstruse topic. If I grasp what you’ve 9
expounded, the human brain
is a concrete, natural object
with a definitely organized structure which 12
perform versatile, subtle
mental functions such as thinking,
planning, or purely imaging something 15

Song 12: *Neurons and their Synaptic Networks*

unreal, as if it were real.
People have used to attribute
them to our “*mind*” which enables us to 18
manage such abstract mental
phenomena. Is my mind just a part
of my brain? If so, where in my brain does it 21
reside? If not, where is
this mind which makes me question it?’
asks Dante in solemnity. ‘I cannot 24
answer such a profound
philosophical question, Dante.
Yet I will try to share with you what I’ve 27
learned how our brain processes
various information at the cellular
level, although it is very provisional 30

Song 12: *Neurons and their Synaptic Networks*

as yet,' says the dreamer,
excited by the challenging tasks.

'The nervous system in all organisms 33
is composed of the structural
and functional units, called "*neurons*,"
and "*glial cells*," which support *neurons* 36
in various ways. Each
neuron has its particular form
to perform its specific neural functions. 39

The common features of
a *neuron* are: its "*soma*" which
contains the "*genome*" in the "*nucleus*" and 42
most of the "*cytoplasm*" in
which "*metabolisms*" occur; its "*dendrites*,"
which extrude from the *soma* to receive 45

Song 12: Neurons and their Synaptic Networks

information from other neurons;
And its “axon,” which is an elongated
protrusion of the “*plasma membrane*” from 48
the *soma* at a swelling,
called the “*axon hillock*.” The *axon*
conveys the integrated information, received 51
via *dendrites* and *soma*,
to its specific target cells,
usually located at long distances away, 54
by means of *electrical*
signals, called “*action potential*”
or “*nerve impulse*.” The distal end of the *axon* 57
makes functional contacts,
called “*synapses*” with its specific
“*post-synaptic target cells*” at their *dendrites* 60

Song 12: *Neurons and their Synaptic Networks*

and *soma*. The “*inter-cellular neural communications*”
between a “*pre-synaptic neuron*” and its target 63
“*post-synaptic cells*” are called
“*synaptic transmissions*.” In the case
of a “*chemically transmitting synapse*” 66
the “*propagation of action potential*” along the *axon*
to its “*pre-synaptic terminal*” enhances 69
the release of its specific
“*neurotransmitter substances*,” packed
in the “*synaptic vesicles*” into the “*synaptic* 72
cleft”, a narrow gap between
the “*pre-synaptic and the post-synaptic membranes*.” The released *neuro-* 75

Song 12: *Neurons and their Synaptic Networks*

transmitters diffuse across
the *synaptic cleft*, and bind to
their “*specific receptors*,” embedded on 78
the “*postsynaptic membrane*”
of a target cell. The binding may
result in changes of “*electrical potential*,” 81
or of “*secondary chemical*
messengers”. Such changes in the *post-*
synaptic cell cause either “*excitation*” or 84
“*inhibition*.” There are many
different “*neurotransmitter*
substances” which play very complex chemical 87
interactions in the “*chemical*
synapses.” In the case of an “*electrical*
synapse”, the *pre-synaptic* and the *post-* 90

Song 12: *Neurons and their Synaptic Networks*

synaptic membranes are connected
by special channels, called “*gap junctions*”
which allow a rapid transmission of 93
“*ionic electric currents.*”
The effect of *synaptic transmission*
is either “*excitatory*” which enhances *post-* 96
synaptic cells to generate
neural signals, or “*inhibitory*”
which suppresses them. Many millions of neurons 99
form a very complex and
intricate “*synaptic network,*”
which performs its specific neural functions. 102
All our mental as well as
physical activities are generated
by such dynamic *synaptic networks* in 105

Song 12: Neurons and their Synaptic Networks

our nervous systems,' says
the dreamer with firm conviction.
'I feel that you have a very intricate story 108
of vital importance
to unfold. But what you've told was
too vague and abstract to grasp. Try to bring forth 111
its essence with concrete
evidences,' says *Dante with earnest*
encouragement. 'I see your point, my revered 114
mentor. I appreciate
your constructive criticism
and encouragement to find the right way to tell. 117
Various sensory neurons
operate on the information, received
from external or internal environments: 120

Song 12: Neurons and their Synaptic Networks

Specific “*receptor cells*”
such as visual, auditory, tactile,
olfactory, or taste modes convert the various 123
information, encoded in
the particular stimuli such as
light or sound into the “*neural language*” 126
used by neurons in common:
The “*electrical potential differences*”
across the “*electrically excitable plasma* 129
membrane of neurons”. Such
conversion is called “*neural trans-*
duction.” The transduced sensory 132
information is processed
via many stages of complex “*synaptic*
integrations” along the sensory pathways which 135

Song 12: Neurons and their Synaptic Networks

project into their specific
regions of the *cerebral cortex*:
For example, the “*visual pathways*” project 138
into the “*primary visual*
cortex” in the *occipital lobe*,
whereas the “*auditory pathways*” project 141
into the “*primary auditory*
cortex in the temporal lobe”.
The “*tactile information*” from the whole body 144
is conveyed to the “*somato-*
sensory cortex in the parietal lobe.”
These sensory projections are organized 147
in “*topographic orders,*”
maintaining “*contiguity*” between
the *location of stimuli* and that of their 150

Song 12: Neurons and their Synaptic Networks

corresponding neurons in
the *cerebral cortex*. Each one of these
neurons has its unique “*receptive field*” 153
which processes specific
features of the stimuli that can
“*excite the neuron selectively,*” says 156
the dreamer. ‘Now I can
follow your story about perception.
I wonder how we perform proper actions 159
to achieve our goals in
our journey of life,’ says *Dante*
with genuine curiosity. ‘An intentional 162
action requires “*planning*
of proper programs” and actual
“*execution of coordinated sequential* 165

Song 12: Neurons and their Synaptic Networks

movements” of various parts
of our bodies. The “*primary motor
cortex in the frontal lobe*” is responsible for 168
performance of “*intended
actions.*” The “*primary motor cortex*”
is composed of many millions of “*upper 171
motor neurons*” which innervate
distant “*lower motor neurons*”
in the “*ventral horn of the spinal cord.*” 174
They are long “*efferent
projections in topographic
order,*” mostly to the “*contralateral*” side. 177
This adjacent larger
region, called “*premotor cortex*”
is involved in more “*abstract aspects 180*

Song 12: *Neurons and their Synaptic Networks*

of motor controls” such as
“*preparation for movement programs*”
and appropriate “*sensory guidance of movements.*” 183

Recently, subtle neurons,
called “*mirror neurons*” were
discovered in the “*rostroventral part*” 186
“*of the premotor cortex*”

in monkeys. These neurons are
active when a monkey grasps an object. 189

If the same monkey attends
to watch a human experimenter grasp
the object in the same way, the same neurons 192

in the monkey’s “*pre-motor*
cortex” become active.’ ‘What? How
fascinating,’ *interrupts Dante*, ‘such neurons 195

Song 12: *Neurons and their Synaptic Networks*

which integrate sensory
and motor information may be
responsible for understanding the actions 198
of others by internally
acting out the observed actions,
using their own motor control processes.’ 201
‘I think so, too, Dante.
The dorsal edge of the *motor*
cortex, called “*supplementary motor area*,” 204
has versatile motor
functions. Each neuron in this part
controls many muscles in various parts of 207
the body in extensively
overlapping patterns. These neurons
are active during “*learning tasks of specific*” 210

Song 12: Neurons and their Synaptic Networks

sequences of movements” in
the monkey brains. The versatile and
subtle functions of the nervous systems 213
come from a vast number
of the possible “*temporal and*
spatial patterns” of neural activities 216
via intricate and complex
“*synaptic interconnections*” among
immense networks of many billions of neurons. 219
Hence, I surmise that our “*mind*”
is not a tangible entity
but the “*on-going activities of immense* 222
and intricately inter-
connected synaptic networks of
many billions of neurons” which process various 225

Song 12: *Neurons and their Synaptic Networks*

neural information, and
execute intentional actions
to manage how to achieve the goals 228
in the journey of our life,’
says the dreamer with resolute
conviction and ardent enthusiasm. 231

Story 13

***Cognitive Functions
of the Human Brain***

Song 13: *Cognitive Functions of the Human Brain*

‘You think that “*mind*” is not
an entity but activity of
our brain,’ *says Dante in a pensive voice.* 3

‘Yes. I believe that we
are used to attribute to “*mind*”
versatile mental functions of the brain, 6
such as attending to,
perceiving, memorizing, recalling,
thinking, planning, imagining, deciding, 9
and being aware of one’s own
on-going mental functions; these
are examples of “*implicit subjective* 12
experiences” of one’s own
brain’s mental capacities. But social
communication with others, using external 15

Song 13: *Cognitive Functions of the Human Brain*

signs such as spoken or
written utterances, is a clear
example of *explicit and objective* 18
mental functions of our brain,
as we converse about them right now.
These mental functions of our brain have been 21
called just as the works of
our *mind*. But we must not confuse
mind with “*soul*” which was made up, as if 24
it were an immortal
entity that could separate from
its dead body, and re-live in a new body 27
as portrayed in the *Myth*
of Er by Plato,’ says *the dreamer*.
‘Which structures of our brain execute such 30

Song 13: Cognitive Functions of the Human Brain

vital and mysterious
functions?’ asks Dante. ‘The anterior
part of the frontal lobe, called “*prefrontal*” 33
 cortex” is one of the most
crucial neural structures which control
cognitive functions: various damages to it 36
 result in specific mal-
functions in mental activities.
Non-invasive “*brain imaging experiments*” 39
 on the brain’s activities,
in terms of differential changes
in the rate of blood flow in different regions 42
 of the brain in normal
people, reveal that significant
increases in the rate of blood flow in specific 45

Song 13: *Cognitive Functions of the Human Brain*

sites of the *prefrontal cortex*
during the subjects execute
certain specific *cognitive tasks*. As the rate 48
of cerebral blood flow was
found positively correlated with
the level of neuronal activities by “*neuro-* 51
physiological experiments”
in monkey brains, the non-invasive
imaging of the human brain activities is 54
useful tools for inferring
which neural networks are more active,
as they use more energy supplied by fresh blood, 57
during execution of
their particular functions,’ *says*
the dreamer. ‘I see. These mental functions 60

Song 13: *Cognitive Functions of the Human Brain*

are executed while we are
awake and alert, I presume. But what
happens in our brain when we sleep and dream?’ 63
asks Dante. ‘The state of
being awake or asleep can be monitored
with the pattern of *electric waves*, produced 66
by the global activities
of the brain, called “*electro-*
encephalography.” Sleeping proceeds in 69
recurring cycles of
“*proper sleep*” and “*paradoxical*
sleep”. During the *proper sleep*, the brain shows 72
three distinct waveforms in
decreasing frequencies and
increasing amplitudes: N1, N2, N3. But it changes 75

Song 13: *Cognitive Functions of the Human Brain*

to high frequency and
low amplitude waveform, “*REM*, ”
during the *paradoxical sleep*, which is more 78
similar to the waveform
in the awake state. The sleeper makes
sustained eye movements during *REM* whereas 81
other parts of the body stay
torpid. A complete sleep-cycle
proceeds from N1 to N2 to N3, back to 84
N2, and then to the REM stage.
It lasts about an hour and a half,
and recurs through the whole period of sleep. 87
Brain-imaging experiments
show that during the *proper sleep*
significant decreases in the blood flow rate 90

Song 13: Cognitive Functions of the Human Brain

in these specific regions
of the sleeper's brain: the "*basal
forebrain*"; the "*ventromedial prefrontal*" 93
cortex"; and the "*precuneus*"
in the parietal lobe. But the *primary*
motor cortex shows little change of blood flow 96
rate during the *proper sleep*.
In contrast, during the *paradoxical*
REM-sleep, the cerebral blood flow increases 99
above the level of the awake state
in various parts of the brain such as
the "*basal forebrain*" and the "*limbic system*" 102
which controls emotion,
motivation, and memory,' *says the man*.
'Why these parts of our brain become hyper- 105

Song 13: *Cognitive Functions of the Human Brain*

active during the paradoxical
sleep?’ asks Dante. ‘We don’t know why
it occurs. I surmise that we need to dream, 108
which happens usually
during the *paradoxical sleep*:
If we wake up sleepers at different 111
stages of REM sleep
in experiments, the awoken subjects
report that they just had dreams in most cases, 114
and they can recall the episodes
of their dreams vividly, whereas
if they are awoken during the *proper sleep*, 117
they are not sure whether
they had dreams which are too vague
to recall. During an eight-hour night sleep, 120

Song 13: Cognitive Functions of the Human Brain

most dreams occur in about two
hours of REM sleep.’ ‘Dreams have been
regarded as supernatural ways to commune 123
with unseen deities, and
the interpretations of dreams made
important impacts in our history. Do you 126
think that our religious faiths
and rituals are related to our brain’s
activities during its paradoxical sleep?’ 129
asks Dante in a sombre mood.
‘I do not know it, Dante. During
dreams, our brains behave as if they were 132
perceiving things in
the absence of actual sensory
stimuli from such things; they are unreal things, 135

Song 13: *Cognitive Functions of the Human Brain*

conjured up from the rich stores
of memories by our brain. It may
enjoy in playing such fun games of making up 138
fanciful tales, carefree
from the stern reasoning, controlled
by the *prefrontal cortex* which is suppressed 141
during our sleep, I surmise,’
says the dreamer. ‘I see. How do we
convert abstract ideas as well as concrete 144
objects and events into
our memories, and then recall them
whenever we need them?’ *asks Dante with* 147
genuine curiosity.
‘*Memories* are the brain’s mental
functions which “*encode, store, and retrieve*” 150

Song 13: Cognitive Functions of the Human Brain

various vital information.

“*Sensory memory*” keeps only briefly
the information sent by various sensory
organs. It decays very

rapidly, unless it is selected
for conversion into “*working memory*”
by cognitive “*attention.*”

Working memory can retain
minimal items of information for
cognitive manipulations

during a short period. Selected
information held tentatively in *working*
memory can be consolidated

into “*long-term memory*” which
has an enormous capacity and duration

Song 13: Cognitive Functions of the Human Brain

for the storage of information.

Long-term memories are classified
into “*explicit memory*” and “*implicit memory*.” 168

The *explicit memories* are
either “*semantic*” or “*episodic*”:
Our knowledge of objective information 171
which can be explicitly
represented by “*words*” is a good
example of “*semantic memory*.” 174

“*Episodic memory*”
refers to private experiences
of events and their relevant contexts. 177

In contrast, “*implicit
memory*” refers to “*procedural
knowledge*”: how to do something properly. 180

Song 13: *Cognitive Functions of the Human Brain*

“*Motor skills*” learned by
practising are its good examples,’
says the dreamer. ‘I see. It is very informative. 183
I wish to know which parts
of our brain process these different
kinds of our memories,’ *says Dante with* 186
genuine enthusiasm.
‘The *working memories* are executed
by the “*dorsolateral prefrontal cortex*” 189
and various structures in
the *parietal lobe*. In contrast,
the *long-term memories* are managed by 192
the “*medial temporal lobe*”
and the “*limbic system*:” A limbic
structure, called “*hippocampus*” is involved 195

Song 13: *Cognitive Functions of the Human Brain*

in consolidating
information from the *working*
memory to “*explicit long-term memory*,” 198
but not for “*implicit*
procedural memory.” Here I
must emphasize that those as mentioned above 201
conjectures are merely
correlational inferences made
from the adverse effects that damage 204
to those neural structures
tend to result in the corresponding
impairments of the various types of memories. 207
The scientific mechanisms—
how those particular, intricate, huge
networks of many billions of various synapses 210

Song 13: *Cognitive Functions of the Human Brain*

encode such vital
information, preserve them for a long
time, and retrieve them whenever we need them 213
to carry on properly
the ever-changing drama in
the journey of our life— remain deep mysteries 216
far beyond my ken and wits,’
confesses the dreamer honestly.
‘It is truly miraculous that our brains can 219
perform such mysterious
epic drama so naturally,’
whispers Dante to himself in deep wonders. 222

Song 14

On Human Communications

Song 14: *On Human Communications*

‘We communicate with other
people to share what we feel, think,
know, imagine, desire, and so on. How do 3
our brains perform such
wondrous and miraculous functions
as we converse about them now?’ *asks Dante.* 6

‘The comprehension and
expression of our abstract “*mental*
representations” of ideas, emotions, and 9
intentions by explicit
use of “*language*” or other “*signs*”
are the most mysterious cognitive abilities 12
unique to the *human brains*,’
says the dreamer, elated in wonder.

‘Tell me what happens in my brain, while I 15

Song 14: *On Human Communications*

listen to what you speak.’
‘As I speak, my brain produces proper
“*acoustic signals*” of *words* which propagate 18
through the air. Your ears transduce
the signals into neural activities,
which are processed by the *auditory pathways* 21
converging to the *primary*
auditory cortex in the temporal
lobe. Then the auditory information of 24
the heard word is “*decoded*,”
presumably by the *explicit*
semantic memory systems, into 27
its referent, concept,
and meaning of the heard word.
Damages to the “*Wernicke’s area*” in the left 30

Song 14: *On Human Communications*

temporal lobe impair
“*comprehension of speech*” in most
cases of right-handed patients. The functional 33
imaging of the brain shows
significant increases of blood flow
in the *left temporal lobe* during performance 36
of speech-comprehension tasks
in the healthy right-handed subjects.
When you hear a particular *syntactic sequence* 39
of words, your brain must figure
out the “*propositional content*” or
the *literal meaning* of the heard sentence, 42
according to the rules
of the grammars, proscribed by
the “*particular sociocultural system*” 45

Song 14: *On Human Communications*

or “*convention of*
our language” which we happen to learn
and use. Furthermore, proper “*interpretations* 48
of actual utterances”
require very subtle and intricate
considerations of the “*pragmatic social* 51
context of the conversation.”
Hence, the comprehension of utterances
requires the hearer to imagine the “*mental* 54
state of the speaker” and
the “*context,*” in addition to
processing the literal meaning of the heard 57
phonological signals:
The hearer must *read the mind* of
the speaker, I speculate,’ *says the dreamer.* 60

Song 14: *On Human Communications*

‘I agree. How about speaking?’
‘Speaking requires much more complex
“*mental operations*:” Before speaking, the speaker 63
must generate the “*message*
of utterance,” which involve complex
cognitive neural networks; one should determine 66
the *purpose* of one’s
“*communicative act*” to the intended
addressee(s) such that the speaking will *affect* 69
them in the “*pragmatic*
context” of the “*illocutionary*
speech act” or “*perlocutionary speech act*”, 72
which requires “*social mental*
representations of the *intended*
addressees’ minds.” How we achieve such wondrous 75

Song 14: *On Human Communications*

mental feats is far beyond
my ken and wit,' *says the dreamer.*
'Yes. It is a miracle we perform somehow, 78
without knowing it,' *says*
Dante. 'Speaking an utterance,
called the "*locutionary speech act,*" is 81
the physical production
of phonological signals which
propagate in the air. It is accomplished 84
by speech organs which are
controlled by the "*primary motor cortex,*"
the "*premotor cortex,*" the "*parietal lobe,*" 87
and the "*temporal lobe.*"
Damages to the "*Broca's area*"
in the left frontal lobe impairs the expression 90

Song 14: *On Human Communications*

of speech in the right-handed
patients. *Imaging experiments* reveal
a corresponding increase of neural activities 93
in the left frontal lobe
during the various speech-production
tasks in the healthy right-handed subjects. 96
The use of language is
a “*lateralized function*” of our brain.
The patients whose cerebral hemispheres are 99
disconnected to relieve
“*epileptic seizures*” by severing
the primary interconnecting “*commissure*,” 102
called “*corpus callosum*,”
can identify verbally the objects
presented only to the *left cerebral hemisphere* 105

Song 14: *On Human Communications*

by speaking or writing.
But they cannot report verbally
the objects presented to the right hemisphere. 108
The same patients, however,
can select those things correctly
presented to their right hemisphere by use of 111
their left hands, which are
controlled by their right hemisphere.’
‘I see. Each cerebral hemisphere seems to have 114
its own mind,’ *says Dante*
in deep thought. ‘For those born without
corpus callosum, their faculty of language 117
may develop in both the left
and the right cerebral hemispheres.
Hence, our brain has amazing plasticity 120

Song 14: *On Human Communications*

during its development.’
‘Yes. No baby can talk at birth.
But all of them acquire their mother tongue, 123
so spontaneously.
What does make our brain develop
to attain its miraculous mental functions?’ 126
whispers Dante to himself.
‘I think that it is the “genome”
in every cell of our body,’ *says the dreamer.* 129
‘Do you mean *the “book of life”*
written in the four-letter alphabet?’
‘Yes, Dante. Recently scientists found a gene, 132
called “*FOXP2*,” which is
located in the “*Chromosome 7*.”
This gene encodes a regulatory protein 135

Song 14: *On Human Communications*

which controls “*selective transcriptions of many other genes:*”
Reading and copying only the selected 138
information in the *Book of Life*. These newly activated
genes may regulate the “*expressions of the next* 141
set of genes,” and so on.
Through such “*complex chained gene-*
regulations,” the *FOXP2* gene controls 144
the “*embryonic development of the nervous system*” and other parts
of the body. Specific mutations in *FOXP2* gene 147
were found to cause a language
disorder, called “*developmental verbal*
dyspraxia” which had been inherited by 150

Song 14: *On Human Communications*

half of the members
of a family in three generations.
The mutation caused a “*substitution*” 153
 of an amino acid
that inhibited the DNA-binding
site of the gene-regulatory FOXP2 protein.” 156
 Further researches provide
evidence that changes in only one
copy of *FOXP2* is sufficient to affect 159
 the normal development
of some parts of our brain, involved
in language function such as the “*basal ganglia*” 162
 and the “*inferior frontal lobe,*”
says the dreamer. ‘I see. It is too
hard for me to understand the mechanisms. 165

Song 14: *On Human Communications*

Yet I do recognize
the vital importance of
the Book of Life, we have inherited from 168
our remote ancestors
through the continuous struggles for
survival, and successfully passing it down 171
to their offspring in the long
journey of our life. This *Tale of*
the Brain is an inspiring revelation to me: 174
I feel the sublime and
sacred nobility of the human
brain which has been pursuing to understand 177
its own profound mystery,'
says Dante, elated in awe and wonder. 179

Song 15

Emergence of Civilizations

Song 15: *Emergence of Civilizations*

‘Using language, we can
transcend time and place miraculously.
We create imaginary and imaginative stories 3
 which are more meaningful
and exciting than mere factual
descriptions of mundane real events. 6
 I wonder how our remote
ancestors acquired such a vital
mental tool, and when did they begin to use 9
 language for their social
interactions,’ *says Dante in deep
meditation.* ‘As any spoken language leaves 12
 no enduring trace, we have no
concrete evidence for when and how
speaking evolved in the *Homo sapience*. 15

Song 15: *Emergence of Civilizations*

About ten-thousand years ago,
our remote ancestors began to
undergo massive revolutionary changes 18
in their lifestyle from “*hunting
and gathering*” to “*farming and
dwelling together*” with many new strangers 21
in their “*settled communities,*”
says the dreamer. ‘What did cause
the agricultural revolution in our prehistory?’ 24
‘It was due to the timely
changes from the harsh cold to mild warm
climate as the “*cycles of the glacial periods*” 27
proceeded on planet Earth.
Fertile lands by great rivers in
Mesopotamia and Egypt became the cradles 30

Song 15: *Emergence of Civilizations*

of “*early civilization*.”

The human societies evolved	
from the “ <i>familial bands</i> ” of about fifty	33
“ <i>hunter-gatherers</i> ” to	
the “ <i>tribes</i> ” of a thousand people	
around seven thousand years ago, and then to	36
the “ <i>chiefdoms</i> ” of ten thousand	
people by five thousand years ago.	
The “ <i>states</i> ” of over hundred thousand people	39
emerged by three thousand	
years ago, and then the “ <i>empires</i> ” with	
population larger than many hundreds of	42
millions at present.	
The organizations of the human	
societies underwent dramatic changes	45

Song 15: *Emergence of Civilizations*

from the “*egalitarian*
hunter-gatherer bands” to the “*stratified*
social hierarchies”: dominant “*ruling classes*” 48
such as king, priest, noble,
and “*subordinate classes*”: citizen,
serf, and slave,’ *says the dreamer*. ‘The usage of 51
a common language must be
absolutely necessary to make
such astounding changes in human societies.’ 54
‘I concur with you, Dante.
The “*private proto-language*” spoken
within a “*band of hunter-gatherers*” must 57
have been assimilated
with those of other bands like a “*pidgin*
language” in a new “*tribe*” or a “*chiefdom*.” 60

Song 15: *Emergence of Civilizations*

Then *local pidgins* might have
evolved to a “*creole language*,”
which had a large *stable vocabulary*, 63
“*consistent grammar*,” and
was “*acquired*” by young children as
their “*native language*” in their nation. 66

The common language spoken
by the whole population of each
country will develop in-depth of thoughts, 69
elegance of its styles,
and various literary arts by
poets, I presume,’ *says the dreamer*. 72

‘It seems a reasonable
conjecture.’ ‘The vast surpluses of
agricultural products increased the wealth and 75

Song 15: Emergence of Civilizations

power of the “*ruling classes.*”
Priests and poets invented countless
imaginary stories about gods, demigods, and 78
superhuman heroes.
The *oral recital of myths* and
public performance of the religious rituals 81
enthralled, and then subdued
the whole population to worship
the “*state-religion*” of the ruling class. 84
The establishment of
their “*state-religion*” with fanciful
“*mythology of deities and superhuman* 87
heroes”, all invented by
using imaginative supple language,
empowered the ruling classes to wield “*theocracy.*” 90

Song 15: *Emergence of Civilizations*

The old egalitarian
“*private worship of their household
deities by the hunter-gatherers*” was 93
suppressed by the newly
institutionalized “*state-religion,*”
and “*theocratic monarchies*” predominated 96
since the early dawn of
our civilization, I surmise,’
says the dreamer with a firm conviction. 99
‘Are there any evidences for
such an audacious hypothesis?’ *asks*
Dante. ‘I will try to provide you with 102
recent archaeological
findings in Mesopotamia.
The “*invention of writing*” by humans 105

Song 15: *Emergence of Civilizations*

about six thousand years ago
was the most crucial event, I think,
because the human history was preserved 108
on written texts only since
that point of time in the long journey
of life on earth. From the ruins of the early 111
civilizations found in
Mesopotamia, archaeologists
excavated vast piles of ancient “*clay tablets*” 114
which preserved old texts,
inscribed by wedge-shaped writings
called the “*cuneiform script.*” The recent success 117
in deciphering these
ancient texts revealed invaluable
glimpses of the earliest history of human 120

Song 15: *Emergence of Civilizations*

civilizations,' *says the dreamer.*

'It is marvellous. What significant
things did the ancient text reveal?' *asks Dante* 123
with genuine enthusiasm.

'The farmers who cultivated
the fertile valleys along the Euphrates 126
and Tigris rivers in

Mesopotamia, called the "*Sumerians,*"
established urban settlements about six thousand 129
years ago. They developed

into separate, independent, and
theocratic "*city-states:*" Each state was ruled 132
by a supreme temple,

dedicated to its particular
human-like patron deity. Its priest-king 135

Song 15: *Emergence of Civilizations*

exerted theocratic power
to govern its subjects. Five “*pre-*
dynastic city-states” which prospered 138
before the “*Great Flood*” are:
“*Eridu,*” “*Bad-tibira,*” “*Larsa,*” “*Sippar,*”
and “*Shuruppak.*” Then, “*dynastic city-states*” 141
rose later, and competed for
hegemony of the “*Sumer:*” “*Uruk,*”
“*Kish,*” “*Ur,*” “*Lagash,*” and “*Adab,*”” says 144
the dreamer. ‘Was each state
ruled by its autocratic monarchs?’
asks Dante. ‘Yes. Archaeologists excavated 147
many *clay-tablets* which listed
the names of monarchs (such as
“*En-me-barage-si,*” “*Aga*” of Kish; 150

Song 15: *Emergence of Civilizations*

“*Lugalbanda*,” “*Gilgamesh*”
of Uruk; “*Ur-Nammu*” of Ur) and
summaries of their major accomplishments. 153
Such documents attest
that each monarch ruled the people
to serve in extensive agricultural projects, 156
or in military campaigns
with absolute theocratic powers,’
says the dreamer. ‘Tell me what you know about 159
the Sumerian religion.’
‘Although I am not qualified,
I will relate what I merely conjecture: 162
The Sumerians envisaged
“*human-like personal deities*”
as follows: “*AN or ANU*” was the divine 165

Song 15: *Emergence of Civilizations*

personification of
the sky, the supreme source of
authority for all other deities and humans. 168

“*KI or ARARU*” was
the consort of *ANU* and
the mother of other Sumerian deities. 171

“*ENLIL*” was the divine
personification of the air, earth,
and storms. He was worshiped as the most 174

powerful god who involved
very actively in human affairs.
His primary center of worship was 177

the “*Ekur Temple*” in
“*Nippur*.” Other kings came to Ekur
Temple to seek for ENLIL’s recognition 180

Song 15: *Emergence of Civilizations*

of their right to rule.
But ENLIL's cult declined after
the sack of Nippur by other city-states. 183
ENLIL was supplanted by
the Babylonian god, "*MARDUK*,"
who became the new supreme god of 186
the whole Mesopotamia
after "*Sargon*" of the "*Akkad*
Dynasty" subdued the Sumerian cities 189
about forty-three centuries ago.
The Sumerian god, "*ENKI or EA*"
was the personification of water, craft, 192
and wisdom. He appeared
in many myths as a benevolent
wise god. "*INANNA or ISHTAR*" was 195

Song 15: *Emergence of Civilizations*

the divine personification
of love, desire, sex, fertility,
attractive power, and war. She was worshiped 198
at the “*Eanna temple*”
in “*Uruk*.” Later, she became
“*APHRODITE*” for the Greeks, and 201
“*VENUS*” for the Romans.
She was portrayed to play active
roles in many myths. “*UTU or SHAMASH*” 204
was the personification
of the sun, justice, morality,
and truth. His cult temples were in “*Larsa*” 207
and “*Sippar*.” He appeared
in many myths for justice in human
affairs. “*NANNA or SIN*” was personification 210

Song 15: *Emergence of Civilizations*

of the moon and wisdom.
His temple in “*Ur*” was called the *house*
of great light. When *Ur* became most powerful 213
among city-states, “*SIN*” was
elevated to the “*Chief of Deities,*”
says the dreamer. ‘Somehow, these alien, bygone 216
Mesopotamian deities
seem strangely so familiar to me,’
whispers Dante to himself. ‘The *invention* 219
of writing made it possible
for the mythology, created by
the bygone Mesopotamian brains, to survive 222
as the *texts inscribed on*
the mud-clay-tablets. These texts have
greatly influenced the Greek brains to invent 225

Song 15: *Emergence of Civilizations*

the extant “*Greek mythology*,”
the Hebrew brains to write their “*Scriptures*,”
the Roman brains to *syncretize Christianity*, 228
and the Arabic brains
to establish the “*Islam*,” long
after the Mesopotamian brains had perished, 231
I think,’ *says the dreamer*.
‘I remember that Abram came from
Ur,’ *says Dante rapt in deep meditation*. 234
‘Writing made another
vital contribution to the human
civilizations: Publication of the “*codes* 237
of judicial laws” for
peoples to abide by. The oldest code,
thus far excavated and deciphered, is 240

Song 15: *Emergence of Civilizations*

the “*code of Ur-Nammu*,”
written forty-one centuries ago.’
‘How do its texts read?’ asks Dante with earnest 243
curiosity. ‘Its solemn
prologue reads: “... After AN and ENLIL
had turned over the kingship of Ur to NANNA, 246
at that time did Ur-Nammu,
the son born of NINSUN, for his
beloved mother, following his 249
principles of equity
and truth... Then did Ur-Nammu
the mighty warrior, king of Ur, king of Sumer 252
and Akkad, by the might
of NANNA, lord of the city,
and following the true word 255

Song 15: Emergence of Civilizations

*of UTU, establish
equity in the land; he banished
malediction, violence and strife, and set 258
the monthly Temple expenses
at ninety gur barley, thirty sheep,
and thirty sila of butter. He fashioned the bronze 261
sila-measure, standardized
the one-mina weight, and the stone-weight
of a shekel of silver in relation to one mina... ” 264*

The laws were arranged in
the form: If [such a crime is committed,
Then [the punishment shall be as follows]. 267

For examples, if a man
commits a murder, that man must
be killed; If a slave marries a free person, 270

Song 15: *Emergence of Civilizations*

he or she must hand the first-
born son over to the owner; If
a man has cut off another man's foot, 273
he must pay ten shekels;
If a man appears as a witness,
but withdraws his oath, he must pay the entire 276
expense of the litigation.
The "*Code of Ur-Nammu*" had firmly
established the lofty paradigm of justice, 279
which inspired subsequent
judicial laws of human societies,'
says the dreamer. After contemplations, 282
Dante speaks in a pensive
voice: 'The "*Code of Ur-Nammu*" is
an eloquent sublime poem that established 285

Song 15: *Emergence of Civilizations*

the sacred principles
of “*Equity*” and “*Truth*” in human
societies!’ ‘Yes, Dante. I concur with 288
your insightful perception.
I think that the Code of Ur-Nammu
was the primogenitor that begot “*codified* 291
constitutions” in the progresses
of human history,’ *says the dreamer*.
‘I acknowledge that it also provides concrete 294
evidences for your audacious
assertions; the monarch invoked
his deities (AN, ENLIL, NANNA, UTU) 297
to justify his theocratic
power and divine right to rule
the peoples in his monarchy (Ur). 300

Song 15: *Emergence of Civilizations*

Hence, the collective worship
of the deities of his “*state-religion*”
by the people was an absolute requirement.’ 303
‘Thank you, Dante, for your kind
magnanimity! Theocracy or monarchy
did not allow people to enjoy the freedom 306
in choosing their own faiths.
The religious freedom is granted
by codified constitutions only in modern 309
democratic nations where
their citizens can elect their rulers
(presidents, prime ministers) by voting 312
with the freedom to choose.
It took long, bloody, awful struggles
for humans to achieve such an enlightened 315

Song 15: *Emergence of Civilizations*

nation: made of responsible
citizens, governed by representatives
elected by citizens, and devoted to promoting 318
liberty, equality,
and prosperity of the whole citizens,’
says the elated dreamer with heartfelt enthusiasm. 321

Song 16

The Epic of Gilgamesh

Song 16: *The Epic of Gilgamesh*

‘The poetry is, I think,
the lofty summit of the noble,
sublime, and imaginative creativity 3
of the mysterious
human brain. Good poets impart
their ineffable deep meanings beyond 6
merely what they say.
I wish to learn about the ancient
poems, written by our remote ancestors,’ 9
says Dante in solemnity.
‘The oldest narrative poem,
thus far excavated from the Mesopotamia, 12
is known as “*The Epic*
of Gilgamesh.” It was compiled
and edited by the great Babylonian master 15

Song 16: *The Epic of Gilgamesh*

scribe-poet, named “*Sin-
leqi-unninni*”, about thirty-two
centuries ago. The poem had been evolved 18
from much older simpler
versions through a long span of two
thousand years, we presume,’ *says the dreamer.* 21
‘I wish to hear the oldest
epic! Please recite it for me,’
says Dante with sincere enthusiasm. 24
‘I’m unable to recite
the whole epic. Yet I love to
share its pithy gist as much as I can.’ 27
‘Good, go ahead!’ *The dreamer
meditates, and then chants from his heart:*
‘ “*Prologue and Paeon:* 30

Song 16: *The Epic of Gilgamesh*

*“He who saw the Deep,
the country’s foundation, was wise
in all matters! He saw what was secret; 33
He discovered what was
hidden; he brought back the eras
unknown before the Deluge. He adventured 36
far away, was weary, found peace,
and set all his labours on a tablet
of stone. He built the rampart of Uruk, 39
the holy temple, Eanna,
for ANU, ARURU, and ISHTAR...
See the tablet box of cedar; release 42
its firm claps of bronze!
Lift the lid of its secret, pick up
the tablet of lapis lazuli, and read out 45*

Song 16: *The Epic of Gilgamesh*

*the travails of Gilgamesh,
all that the hero went through!”*

How does the Prologue sound to you, Dante?’ 48

‘I am deeply moved by
such a wise and eloquence voice,
coming alive from time immemorial. Keep on 51

narrating the majestic
epic!’ ‘Gilgamesh surpassed all
other kings; he was heroic in stature, 54

the brave scion of Uruk,
and the strong bull on the rampage.

Going at the forefront, he was the invincible 57

vanguard; guarding at
the rear end, he was the loyal protector
of his comrades in wars. King Lugalbanda 60

Song 16: The Epic of Gilgamesh

was his sire; Goddess NINSUN,
well versed in counsel, was his loving
mother. When he grew tall his beauty was 63
consummate; by earthly
standard, he was the most handsome man.
His head held aloft in pride, Gilgamesh lorded 66
Uruk in tyranny: He had
no equal when he wielded his weapons.
The young men of Uruk he harassed without 69
warrant, letting no son
go free to his father. By day
and by night his tyranny grew harsher; he made 72
no daughter go free to
her mother, nor girl go free to
her bridegroom. The people of Uruk voiced 75

Song 16: *The Epic of Gilgamesh*

their troubles to ANU,
the mighty father of all gods:
“A savage wild bull you have bred in Uruk; 78
Although Gilgamesh is
our shepherd-king and powerful,
expert, and pre-eminent protector, 81
he lets no girl go free
to her bridegroom.” The almighty god
ANU heeded their complaint. He summoned 84
his wife, ARURU, the greatest
goddess, and spoke: *“You, ARURU*
who created the humans, now fashion what 87
ANU has thought of: Make
an equal of Gilgamesh; let him
be a match for the storm of his heart; let them 90

Song 16: *The Epic of Gilgamesh*

*vie each other so that Uruk
may be rested!”* The goddess ARURU
heard these words of ANU. She took a pinch 93
of clay, breathed life into it,
and threw it down into the wild.
She made the wild man, Enkidu, who was 96
brought up by beasts in the wild.’
‘Excellent plot!’ *exclaims Dante,*
‘It reminds me of the creation of Adam 99
in *Genesis*. How did King
Gilgamesh meet with the wild man?’
‘A hunter saw the mighty wild man who pulled up 102
his snares and set free the trapped
beasts, ruining all his work. He reported
what happened to King Gilgamesh. He ordered 105

Song 16: The Epic of Gilgamesh

the hunter to take with him
Shamat, the harlot, to meet the wild
man, and enthrall him with her expert woman's 108
art of making love to man,
and bring him to Uruk to vie with
Gilgamesh. Shamat met Enkidu, lured him 111
to leave the wildness, tamed him,
and led him to Uruk. One day
Enkidu blocked the door of a wedding house, 114
not allowing Gilgamesh
to enter; they seized each other,
and contested their powers. Soon both of them 117
recognized that they were
great equals like twins; they quit fighting
and vowed each other that they would be faithful 120

Song 16: *The Epic of Gilgamesh*

friends to the end. NINSUN
blessed them as brave, splendid, and
loving brothers. Soon, Gilgamesh convened 123
the assembly of Uruk,
and spoke from his throne: *“Hear me,
elders of Uruk: I will venture afar to 126
the thick Forest of Cedar
with my brave trusty companion,
Enkidu, and conquer its strong ferocious 129
guardian, Humbaba.
Let the whole world learn that Uruk’s
offshoot is mighty. I will establish a name 132
eternal for my heroic
deed.”* Enkidu offered counsel:
“Who would dare to conquer Humbaba? His voice 135

Song 16: The Epic of Gilgamesh

*is the Deluge; his speech
is fire; his breath is death! The mighty god
of Earth, ENLIL made it his lot to terrify men* 138
*to keep his scared Forest
of Cedar safe.” Then elders spoke:
“You are young, Gilgamesh, borne along by pride* 141
*and passion; you do not
understand what you are talking
to do.” But proud Gilgamesh was adamant.* 144

He pled NINSUN to obtain
crucial help from the sun god,
SHAMASH, for his daring expedition. 147

Gilgamesh and Enkidu
ventured forth afar to conquer
Humbaba. After long hard journeys, they 150

Song 16: *The Epic of Gilgamesh*

reached the thick Forest
of Cedars, and met head-on with
powerful Humbaba. Fiercely they fought 153
for life or death in gory
struggles. With the crucial help
of SHAMASH, Gilgamesh defeated Humbaba. 156
He begged Gilgamesh
to spare his life, but Enkidu said:
“*Gilgamesh, slay him before ENLIL hears* 159
what we do! The great gods
will take against us in anger.
Establish your fame that will endure forever 162
how Gilgamesh slew
Humbaba!” Hence, Gilgamesh smote
Humbaba in the neck, carried the head 165

Song 16: *The Epic of Gilgamesh*

as his trophy, and
returned to Uruk with Enkidu
in splendid glory of his heroic triumph.’ 168
‘How does the tragedy
of Gilgamesh unfold next
in retribution of his arrogant pride?’ 171
asks Dante. ‘The people
of Uruk welcomed Gilgamesh
as their supreme heroic king: they adored 174
him as if he were a god.
ISHTAR, the goddess of love
and war, fell in love with him. She proposed: 177
“*Come Gilgamesh, be you,
my bridegroom! Grant me your fruits!
Be you, my dear husband and I, your wife!*” 180

Song 16: *The Epic of Gilgamesh*

But Gilgamesh refused
her lure, recounting how cruelly
she had ruined wretched victims of her previous 183
love-affairs. In furious rages,
the insulted ISHTAR pleaded her
father, ANU: *“Proud arrogant Gilgamesh 186*
scorned me with foulest
slanders and vile insults. Let me have
the Bull of Heaven so that I may punish him 189
for his audacity.
If you forbid it, I will smash
the gates of the Netherworld, and bring up 192
the dead to consume
the living!’ Reluctantly, ANU
gave her the Bull of Heaven. When ISHTAR 195

Song 16: *The Epic of Gilgamesh*

came down with the Bull,
it devastated Uruk, killing
many hundreds of people. Brave Enkidu 198
rushed to the rear of
the Bull. He seized it by its tail.
Then Gilgamesh thrust in his knife between 201
the yoke of the horns like
a skilled butcher. After they had
slain the Bull, they bore its heart aloft, and 204
offered it to SHAMASH.
Suddenly, Enkidu fell deadly
sick. In awful delirium, he saw the gods 207
condemning him to death.
When he awoke, he spoke to Gilgamesh:
“Hear me, my brother, what I saw in my dream: 210

Song 16: *The Epic of Gilgamesh*

*In the assembly of the gods,
ANU spoke to ENLIL: ““Because
they slew the Bull of Heaven and Humbaba, 213
one of them must die, now.””
Enlil said: ““Let Enkidu die first!””
Thus, soon I shall cross the threshold of death, 216
and sit among the dead!
I who endured all hardship with you,
remember me, my brother, Gilgamesh. 219
Do not forget all what
I went through with you!” Enkidu lay
on the bed; his sickness worsened day by day, 222
never to rise again.
On his last hour Enkidu spoke
to Gilgamesh: “My god has taken against me: 225*

Song 16: *The Epic of Gilgamesh*

*I do not die like one
who falls in the midst of battle:
I shall not make my name!"* The sudden death 228
of brave young Enkidu
was like a fatal death-blow to
Gilgamesh in ghastly fears of death, 231
tormenting him endlessly.
After solemn stately funeral
of his beloved companion Enkidu, 234
Gilgamesh left his kingship
of Uruk, and wandered the wildness
to find Utnapishtim, the sage at the end 237
of this world who had
attained his immortality. At last, he
came to Mashu, the twin peaks where the sun rose 240

Song 16: *The Epic of Gilgamesh*

and set. They guarded the sun's
daily journey. Their high summits
supported the fabric of heaven, while their deep 243
base reached down to the dark
Netherworld. There were scorpion-men,
guarding its gate, whose terror was dreadful, 246
whose piercing keen glance was
like death. Gilgamesh saw them; in fear
and dread he covered his face; then he regained 249
his guts, and drew nearer
to them. The scorpion-man called out:
"How did you come here in such a far way? How 252
did you cross the seas whose
passages are perilous? Let me learn
of your journey from afar!" Gilgamesh said: 255

Song 16: *The Epic of Gilgamesh*

*“I am Gilgamesh from
Uruk; I am seeking the way
to reach my forefather, Utnapishtim, 258
who attended the gods’
assembly, and attained life
eternal; he shall tell me the secret 261
of death and life!” “Never
before was there one like you,
Gilgamesh. Never did anyone travel 264
the mystic path through this
mountain. For twelve double hours,
its dark interior extends; light there is none. 267
How will you go through it?”
“My will is resolute to reach
the Distant Realm of immortality. 270*

Song 16: *The Epic of Gilgamesh*

*I will endure all
adversities in humility,
and overcome dire perils to achieve* 273
*my sacred vows. Humbly
I implore you to allow me
to enter your gate,” said Gilgamesh.* 276
*“Go, Gilgamesh! May Mashu
allow you to pass; may it help you
continue your journey in safety!” said* 279
*the guardian. Gilgamesh
took to heart what he heard; he took
the hidden path of the Sun God. The darkness* 282
*was dense inside; light was
there none; it did not allow him
to see behind. He kept on pursuing forward.* 285

Song 16: The Epic of Gilgamesh

Reaching twelve double-hours,
Gilgamesh came out at last ahead
of the sun. He saw a marvellous garden, 288
 resplendent with many trees
of jewels growing on their branches
in splendour by the shore of the mystic sea. 291
 Siduri was a tavern-
keeper who lived by the seashore.
She saw a stranger, clad in a pelt and fearful 294
 to look on, coming towards
her dwelling. Alarmed, she barred her gate,
and went up on the roof. Gilgamesh threatened 297
 to smash the door and shatter
the bolt. Siduri asked who he was
and why he had come to her. Gilgamesh 300

Song 16: *The Epic of Gilgamesh*

told her what he had achieved.

*“If you and Enkidu were such brave
heroes who slew Humbaba and the Bull
of Heaven,”* asked Shiduri,

*“Why are your cheeks so hollow,
your face so sunken, and your mood so wretched
in sorrow? Why do you
wander the wild, clad in lion’s pelt?”*

*“My friend Enkidu, whom I loved so dear,
who went with me through
every danger, the doom of mortals
overtook him. I did not surrender his body
for burial until maggots*

*dropped from his nostrils. Then I became
afraid that I, too, would die. I grew fearful*

Song 16: The Epic of Gilgamesh

*of death; What became
of Enkidu was too much to bear,
so, on far paths, I wander the wildness. 318*

*How can I stay quiet?
Shall I not also lie down soon, never
to rise again through eternity? Tell me where 321*
the road to Utnapishtim is!

*What is its landmark? If it may
be done, I will cross the sea to see him; 324*

*If not, I will wander
the wild,” said Gilgamesh in earnest.*

“Never there has been a path across nor since 327
*olden days can help any
human cross the sea. It is perilous,
full of hazard; Its midway lies the Waters 330*

Song 16: The Epic of Gilgamesh

*of Death. But if you
could persuade Urshanabi,
the boatman of Utnapishtim, and his crews, 333
the Stone Ones, they may help
you. Go then, Gilgamesh, to the forest
to find him picking pines. Let him see your face. 336
If it may be to go
with him to cross the sea, go; if not,
turn around and go back home in peace!” said she. 339*

Gilgamesh found them
in the forest; he rushed down on them;
The Stone Ones, who crewed the boat without 342
being harmed by the Waters
of Death, rash Gilgamesh smashed, and
threw them in the river. Astounded Urshanabi said: 345

Song 16: The Epic of Gilgamesh

*“Who are you? Why have you
come here, afar?” “I am Gilgamesh
from Uruk. I wandered long looking for 348
Utnapishtim to learn
the mystery of death and life. Please
help me reach his unseen realm of Distant!” 351
“Ah, rash Gilgamesh! You
hampered your goal by smashing
the Stone Ones, my dear expert crews. If you 354
want to cross the Waters
of Death on my boat, cut three hundred
long punting poles, trim them with a boss, and bring 357
them to me,” said Urshanabi
in a stern voice. Willingly Gilgamesh
obeyed him. At last, they launched the boat. 360*

Song 16: *The Epic of Gilgamesh*

When they came to the Waters
of Death, Urshanabi said: “*Take*
punting poles, Gilgamesh! Don’t touch water 363
lest you die.” When Gilgamesh
had used all punting poles, Urshanabi
took off his garment to use it as a sail. 366
After much toils, they reached safe
the blessed shore. At last, Gilgamesh
saw Utnapishtim, the immortal Distant, 369
face to face, and said:
“*I look at you, Utnapishtim;*
Your form is no different from mine; you are 372
just like me. How did you
stand with the gods in their assembly?
How did you find the life eternal?” Then 375

Song 16: *The Epic of Gilgamesh*

Utnapishtim spoke:

*“I will reveal to you, Gilgamesh,
a matter most secret: The gods decided 378
to send down the Deluge.*

*Wise god EA said to me: “Demolish
the house and build a boat! Abandon wealth and 381
seek survival! Spurn property,
save life! Take on board the boat all
living things’ seeds!”” I built the boat in time. 384*

*As the weather became
foreboding, I went into the boat.
Soon, gale winds flattened the country, then came 387
the Deluge: The dreadful
cataclysm devastated the people.
Even the gods took fright at the Deluge. 390*

Song 16: *The Epic of Gilgamesh*

*They left and went up to
the heaven of ANU, lying like dogs
curled up in the open. Goddess ARARU 393
cried out like a woman
in childbirth, whose voice was so sweet:
““The olden times have turned to clay, because 396
I spoke evil in the gods’
assembly. How could I declare
a war to destroy my people? It is I 399
who gave birth to them; they
are mine! And now, like fish, they fill
the sea!”” When the Deluge ended at last, 402
I made offerings to
the gods in thanks. They gathered like
flies around me, making sacrifices. Then ARARU 405*

Song 16: *The Epic of Gilgamesh*

*came, and said: “All gods shall
come to enjoy the incense except
ENLIL, because he lacked counsel and brought 408
on the Deluge, and destroyed
my people.” But ENLIL arrived;
He saw the boat. He was seized with anger, 411
filled with rage at the gods
of Igigi: “How did this man escape
the Deluge? No one was meant to survive 414
the destruction!” NINTURA
said to ENLIL: “Who, if not EA,
could cause such a thing? EA alone knows how 417
all things should be done.”
Then wise god EA spoke to ENLIL:
“You, the chief of the gods, ENLIL, how could 420*

Song 16: *The Epic of Gilgamesh*

you lack counsel and bring on
the Deluge? We should punish only
those who do wrong and transgress, not the good 423
and innocent people.

I did not disclose the gods' secret
to Utnapishtim: His wise mind foresaw 426
the gods' secret. Now, ENLIL,
you decide what to do with him!"

Then ENLIL came up inside my boat: 429

*Touching our foreheads,
ENLIL blessed my wife and me:*

"Utnapishtim was a mortal man, but now 432
he and his wife shall become

like us gods! They shall dwell far away,
where the rivers flow forth!" *Thus have we* 435

Song 16: *The Epic of Gilgamesh*

attained our eternal life,
Gilgamesh.” The wise sage finished
his recollection of the mystic past. 438
“*Now I understand how*
you became immortal;” said Gilgamesh,
“*Please tell me how I should search for such* 441
an eternal life?”
“*I know not who would convene for you*
the gods’ assembly to decide it. Let me 444
test you for an easy trial:
For six days and seven nights, come,
do without slumber!” But Gilgamesh fell into 447
a deep sleep as soon as
he squatted down. When Utnapishtim
awoke him at the end of the entire test period, 450

Song 16: *The Epic of Gilgamesh*

wretched Gilgamesh bewailed:
“O Utnapishtim, what should I do?
Where should I go? A thief has taken hold 453
of my flesh! Death abides
in my bedchamber; wherever
I turn, there too will be death!” Utnapishtim 456
spoke to his boatman: “May
the quay reject you, Urshanabi;
The ferry scorns you! You who used to walk 459
this shore, I banish you
from it now! For the man that you
led here, take him to the washtub and clean him: 462
Let him cast off his filthy pelts
to the sea; let his body be soaked till fair;
Let him wear royal robes, fitting to his dignity! 465

Song 16: *The Epic of Gilgamesh*

*Until he reaches the end
of his road and home in his city,
let the robe stay clean and fresh!” Then his caring* 468
*wife said: “Gilgamesh came
here by toil and travail. What have you
given the hero for his homeward journey?”* 471
At the departure of
Gilgamesh with Urshanabi,
the sage spoke: *“There grows a magic plant* 474
*in the Ocean Below;
It looks like a boxthorn. It prickles
like a dog-rose and will prick one who plucks it.* 477
*But if you can possess this plant,
you will stay young as long as you
keep it.”* On the way home, Gilgamesh dived 480

Song 16: *The Epic of Gilgamesh*

deep down to the bottom
of the Ocean; He found the plant,
and took it with him up the shore. In joy 483
he spoke to the boatman:
*“This plant, Urshanabi, is the Plant
of Heartbeat; with it, a man can regain 486
his vigour. To Uruk
I will take it; to an ancient
I will feed some and put the plant to the test. 489
Its name shall be ““Old man
grown young’”; I will eat it myself
to keep my youth!”* While Gilgamesh bathed in 492
refreshing pool, a snake caught
scent of the plant, came up in stealth,
and bore the plant off. Then Gilgamesh lamented: 495

Song 16: *The Epic of Gilgamesh*

*“For whom toiled my arms so hard?
For what ran dry the blood of my heart?
Not for myself did I find the bounty. Had I* 498
*only turned back and left
the boat on the shore!” Bearing all
hard toils, travails, and despairs, Gilgamesh* 501
*and his loyal friend arrived
in Uruk at last. In tears, he spoke:
“O Urshanabi, climb Uruk’s wall, and walk* 504
*back and forth! Survey
its foundation! Were its bricks not
fired in the oven? Did seven sages not lay* 507
its invincible foundation?”
At the end of his heroic
journey of life, lying on his deathbed, 510

Song 16: *The Epic of Gilgamesh*

never to rise again,
Gilgamesh had a numinous dream:
He was drawn nigh to the assembly 513
of the gods. ANU spoke:
*“Gilgamesh! You have travelled each
and every road, fetched the unique cedar 516
down from its mountain home,
smitten Humbaba in his forest, and
killed the Bull of Heaven. You have set up 519
monuments for future days,
founded temples of the gods, and reached
Utnapishtim in his Distant abode! The rite 522
of Sumer, forgotten there
since far-off days of old, the rituals
and customs, it was you who brought them back 525*

Song 16: *The Epic of Gilgamesh*

*to the land. Hence shall you be
the divine judge of the dead forever!”*

Thus ends the “*Epic of Gilgamesh*,” the oldest 528
and yet the most profound story,
created by the human brain, I know of,
Dante!’ *says the elated dreamer earnestly.* 531

Song 17

***In Search for Objective
and Universal Laws of Nature***

Song 17: *The Objective Laws of Nature*

‘The story of Gilgamesh
takes my breath away in awe, heartfelt
empathy, and sublime spiritual awakening 3
to learn how deep the wise
ancient poets saw the mystery
of the human destiny. Now, I realize 6
that the Holy Bible
is a collection of the syncretic
old stories which had been written and rewritten 9
by human authors through
the rise and fall of civilizations
in our history,’ *says Dante in deep thoughts.* 12
‘Just as peoples speak in
various languages, different cultures
have developed their unique modes of diverse 15

Song 17: *The Objective Laws of Nature*

deities to worship. It is
our intrinsic nature, I presume,
to invent *deities* in our mind to fulfill 18
our innate necessity
to worship *them* as if they existed
in themselves to create the whole universe 21
and all things in it,' *says*
the dreamer. 'Why is it necessary
for humans to worship deities?' *asks Dante*. 24
'I presume that human's
keen awareness of death and
innate fear of their inevitable death 27
make it necessary for them
to make up *deities* in their minds,
and believe in their own individual afterlife 30

Song 17: *The Objective Laws of Nature*

as immortal “*souls*” that
are supposed to transcend their births
and deaths, magically. Much more importantly, 33
the human societies
have been using their *deities* as
the most powerful *spiritual weapons* to use 36
in their dire political
struggles for survival, and to unify
their diverse members. Hence, their inventions 39
of *deities*, suitable for
their particular society’s needs
have been the crucial necessity for 42
their survival in harsh
struggles for existence on Earth,’
says the dreamer. ‘I recall that is what 45

Song 17: *The Objective Laws of Nature*

you've persisted with. But how
the humans—paltry helpless creatures
fleeting back to dust—could invent such sacred 48
and omnipotent gods
in their inane minds?' *asks Dante.*
'By use of their language! The humans create 51
the gods and the whole universe
with words in their minds: they speak of
things real as well as what they purely imagine 54
as if they were all true.
Great imaginative poet-priests
of various cultures have made up fanciful 57
glib myths of subtly conjured
gods, enthralling the minds of peoples
with peerless powers as if they were the very 60

Song 17: *The Objective Laws of Nature*

demi-gods sanctified by
their deities in a theocracy,' *says*
the dreamer. 'If the omniscient and 63
omnipotent deities had
never existed as you insist,
then how could the universe and all things in it 66
work in perfect harmony?'
asks Dante. 'I believe that every
real thing and all actual events in the universe 69
occur naturally
in accord with the "*ultimate*
and universal principles of nature.'" 72
They are abstract, abstruse,
and objective "*principles or laws*
of nature" unlike any *human-like deities* 75

Song 17: *The Objective Laws of Nature*

invented by priests,' *says*
the dreamer resolutely. 'If so,
such *impersonal principles* should have nothing 78
to do with human affairs.

Most of all, humans can never know
such objective, universal, and ultimate 81
principles of nature,
as confessed by wise Xenophanes,'
says Dante. 'Completely, I agree with you. 84

It is impossible
for humans to know perfectly
the ultimate principles of nature. 87

But humans can search for
such objective laws of nature
by approximate empirical methods: 90

Song 17: *The Objective Laws of Nature*

We make many observations
of each particular phenomenon
under various experimental conditions; 93

Then, we test logical
inferences for the possible
causes of each phenomenon by using 96
mathematical equations,’
says the dreamer. ‘I gather that
you tell something of vital importance; 99

But I cannot grasp it
as you’ve expressed; make it plain
and explicit,’ *says Dante with curiosity.* 102

‘Yes, I will try it again:
We may have different opinions
about a particular phenomenon; but 105

Song 17: *The Objective Laws of Nature*

mere opinions are not
useful unless they are formulated
into “*testable hypotheses*” by experiments. 108

If the predictions of
a testable hypothesis agree
with the results of experiments, then we 111
accept the hypothesis
as one of the possible “*theories*. ”

But all “*theories*” are provisional opinions 114
that most humans accept
tentatively to be valid until
they find new phenomena which contradict 117
them. Hence, we cannot claim
that our currently held “*theories*” are
the ultimate principles or laws of nature, at all,’ 120

Song 17: *The Objective Laws of Nature*

says the dreamer. ‘I see
that it is a keen analytical way
of thinking,’ *says Dante rapt in deep thoughts.* 123

‘The new frame of mind is known
as the objective “*scientific researches*,”
which emerged three centuries after your era,’ 126

says the dreamer. ‘Do you think
that the scientific researches brought forth
fundamental changes in the ways how modern 129
humans think and live?’

asks Dante. ‘Yes, I think that
they made the most vital and enlightening 132
achievements in the long
journey of life; a by-product
of natural processes of evolution— 135

Song 17: *The Objective Laws of Nature*

the human brain—begins to
look into its own profound mystery
in the esoteric drama of the universe,’ 138
says the dreamer. ‘I wish
to hear what you keep in your mind,
my dear, strange, and imaginative dreamer,’ 141
says Dante with heartfelt
enthusiasm. ‘I will try my best
to unfold plainly what the human brains 144
have recently discovered
on the “*nature of the universe*”
and its profound mystery. It will be merely 147
a provisional tale
that will evolve as our scientific
researches progress in time. Yet, I hope that 150

Song 17: *The Objective Laws of Nature*

it is a meaningful
and soul-searching story for us
to converse on,' *says the dreamer, elated in awe.* 153

[To be continued in:

***Mystery of the Universe:
Conversing with Dante in Dream {3}]***

Epilogue

[A] The conversation between the two characters, ‘Dante’ and the ‘dreamer,’ in this fictional narrative, *Journey of Life on Earth: Conversing with Dante in Dream {2}*, is merely an imaginary invention. Yet, the author has toiled to make them rely on the relevant general knowledge of the modern sciences to the best of his ability, although they are provisional.

[B] The author hopes that the present narrative is readable by any sincere readers to grasp the gist of each topic without professional training in the modern sciences such as molecular biology, neuroscience, linguistics, and archaeology.

All technical terms used in this work are indicated by quotation marks in italics (e.g., “*cell*,” “*genome*,” “*DNA*,” “*nucleobase-pairing*,” etc.). The author checked the accuracy of each technical term by consulting the online encyclopedia: www.wikipedia.org. He wishes to thank **the Wikipedia** for providing humanity with invaluable intellectual resources. As for expert explanations of the technical terms used in this work and their relevant references, please consult: www.wikipedia.org.

[C]. The following books provide the essential background knowledge on the relevant topics unfolded in *Journey of Life on Earth*:

(C-1). For the topics of Songs #1- # 9:

Cell Structure and Function by Loewy, A. G. and

Siekevitz, P. (1963). Holt, Rinehart & Winston

Molecular Biology of Bacterial Viruses by Stent, G. S.

(1963). H.W. Freeman

Molecular Biology of the Cell by Albert, B., Johnson, A.,

Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P.,

Watson, J.D. (1983-2016). Garland Science Publication

The Origin of Species by Means of Natural Selection

by Darwin, Charles., (1859). Reprinted in The Modern

Library, Random House

The Descent of Man and Selection in Relation to Sex

by Darwin, Charles., (1871). Reprinted by Random

House

The Ascent of Man by Bronowski, J. (1973) Science

Horizon Inc.

The Third Chimpanzee by Diamond, J., (1992) Harper

(C-2). For topics of Songs #11 - #14:

From Neuron to Brain by Kuffler, S. W., and Nicholls, J. G., (1976). Sinauer

Essentials of Neural Science and Behavior by Kandel, E. R., Schwartz, J. H, Jessell, T. M., (1995). Appleton & Lange

Development and Plasticity of the Brain by Lund, R. D., (1978). Oxford University Press

Principles of Neural Development by Purves, D. and Lichtman, J. W. (1985). Sinauer

Brain Circuits and Functions of the Mind: Essays in Honour of Roger W. Sperry. Edited by Trevarthen, C., (1990). Cambridge University Press

(C-3). For the topics on language (Song #14):

Course in General Linguistics by Ferdinand de Saussure
Translated by Harris, R. (1983) Duckworth & Co.

Introduction to Theoretical Linguistics by Lyons, John.
(1968) Cambridge University Press

Pragmatics by Levinson, S. C., (1983). Cambridge
University Press

(C-4). For topics of Mesopotamian religion (Song #15):

The Treasures of Darkness: A History of Mesopotamian Religion by Jacobsen, Thorkild. Yale Univ. Press (1976).

(C-5). For the topics of the Epic of Gilgamesh (Song #16):

The Epic of Gilgamesh. Translated by George, Andrew. Penguin Classics (2003).

[D] About **Song10: *Artistic Creativity of Early Humans***

This topic is merely a personal subjective feeling of the naïve author who had only indirect experiences through virtual visits of the prehistoric paintings at the Chauvet and Lascaux and other prehistoric caves via the internet. It is not an objective view of a qualified archeologist of the prehistoric arts, at all.

(D-1). Chauvet cave in France

<http://archeologie.culture.fr/chaudet/en/virtual-visit>

(D-2). *Cave of Forgotten Dreams*: A documentary film by Werner Herzog (2010).

(D-3). Lascaux cave in France

<http://archeologie.culture.fr/lascaux/en/virtual-vist>

(D-4) *LASCAUX en Perigord Noir* by Vouvre, J., Brunet, J., Vidal, P., Marsal, J. Pierre Fanlac, France (1985).

(D-5). *Encyclopedie illustree de L'Homme Prehistorique*
Compiled by Jelinek, Jan. Grund, France (1985).

(D-6) *Art et Civilisations des Chasseurs de la Prehistoire*. Published by Laboratoire du Musee de l'Homme and Musee des Antiquites Nationales de Saint-Germain en Laye, France (1984).

(D-7) *A Study of the Ba Concept in the Ancient Egyptian Texts* by Zabkar, Louis, V.
The Oriental Institute,
University of Chicago Press (1968).

[E] The author wishes to share this plain work as a heartfelt *hymn to life* with his fellow sojourners who happen to come across on this path in the mysterious journey of our life.

Art Aeon

